APPENDIX C BIOLOGICAL SURVEY REPORTS

CONTENTS:

- Raptor Nest Survey Report
- Sharp-Tailed Grouse Lek Survey Report
- Wildlife Baseline Studies Report and Avian Survey Update
- Habitat Report
- Bat Acoustic Monitoring Report
- Whooping Crane Habitat Review

ENVIRONMENTAL & STATISTICAL CONSULTANTS
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July 11, 2013

Casey Willis
Sunflower Wind Project, LLC
3760 State Street, Suite 102
Santa Barbara, CA 93105

RE: Sunflower Raptor Nest Surveys

Dear Mr. Willis,

As part of agency approved baseline survey efforts, surveys for raptor nests were completed at the Sunflower Wind Energy Project (Project) on April 2, 2013 by a qualified biologist from Western EcoSystems Technology, Inc. Surveys were completed from the air in a helicopter before leaf out when raptors would be actively tending to a nest or incubating eggs. Aerial surveys were conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service (USFWS) Inventory and Monitoring Protocols (Pagel et al. 2010). An experienced raptor ecologist and a helicopter pilot skilled at this type of survey were used. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. Surveys focused on locating large, stick nest structures in suitable raptor nesting substrate (trees, transmission lines, cliff faces, etc.) within the proposed Project and a one mile buffer. Additionally, a second buffer was surveyed out to 10 miles to document any eagle nests (Figure 1). Efforts were made to minimize disturbance to nesting raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying depending upon nest location and wind conditions.

In general, all potential eagle and raptor nest habitat was surveyed, flying at speeds of 60-75 mph throughout the proposed Project and associated buffers. Additionally, one known bald eagle (*Haliaeetus leucocephalus*) nest location provided by the North Dakota Game and Fish Department (NDGFD 2013) was surveyed for nest status and condition. The survey was conducted between 0800 hours and 1700 hours. The locations of all potential raptor nests were recorded using a hand-held Global Positioning System (GPS); coordinates were set at Universal Transverse Mercator (UTMs) North American Datum (NAD) 83 unit. This included all confirmed and potential nests regardless of their activity status. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or

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whitewash. Attempts were made to identify the species of raptor associated with each active nest. Additionally, date, nest condition, and habitat were recorded. Nests located incidentally during ongoing avian point count surveys started in spring 2013 have also been included with the nest survey results reported below.

During the 2013 aerial survey and/or incidentally during avian point counts, 18 raptor nests representing five species were documented within the Project and associated buffers (Tables 1 and 2; Figures 1 indicates bald eagle nests and 10 mile buffer and Figure 2 indicates raptor nets within 1 mile buffer). Of these nests, the historic eagle nest noted by the NDGFD was confirmed as an occupied bald eagle nest, four nests were identified as potential inactive bald eagle nests (i.e. large enough for a bald eagle to use), one occupied/active burrowing owl (*Athene cunicularia*) nest, three occupied/active great horned owl (*Bubo virginianus*) nests, three occupied/active red-tailed hawk (*Buteo jamaicensis*) nests, three occupied/active Swainson's hawk (Buteo swainsoni) nests, and three inactive raptor nests (Table 1, Figures 1 and 2). No potential or occupied bald eagle nests were located within the project or 1 mile buffer, all were approximately 8 miles or more from the project boundary (Figure 1)

Incidental observations included seven separate sightings of bald eagles flying or perched within the 10-mile buffer, as well as a potential bald eagle winter roost site along the Heart River (Table 3, Figure 1). The potential bald eagle winter roost consisted of several bald eagles of different ages perched in trees along the river during the morning hours. It is not known if this is a regular roost location.

If you have any questions or require additional information, please feel free to call me at 701-250-1756.

Sincerely,

Clayton Derby
Senior Manager

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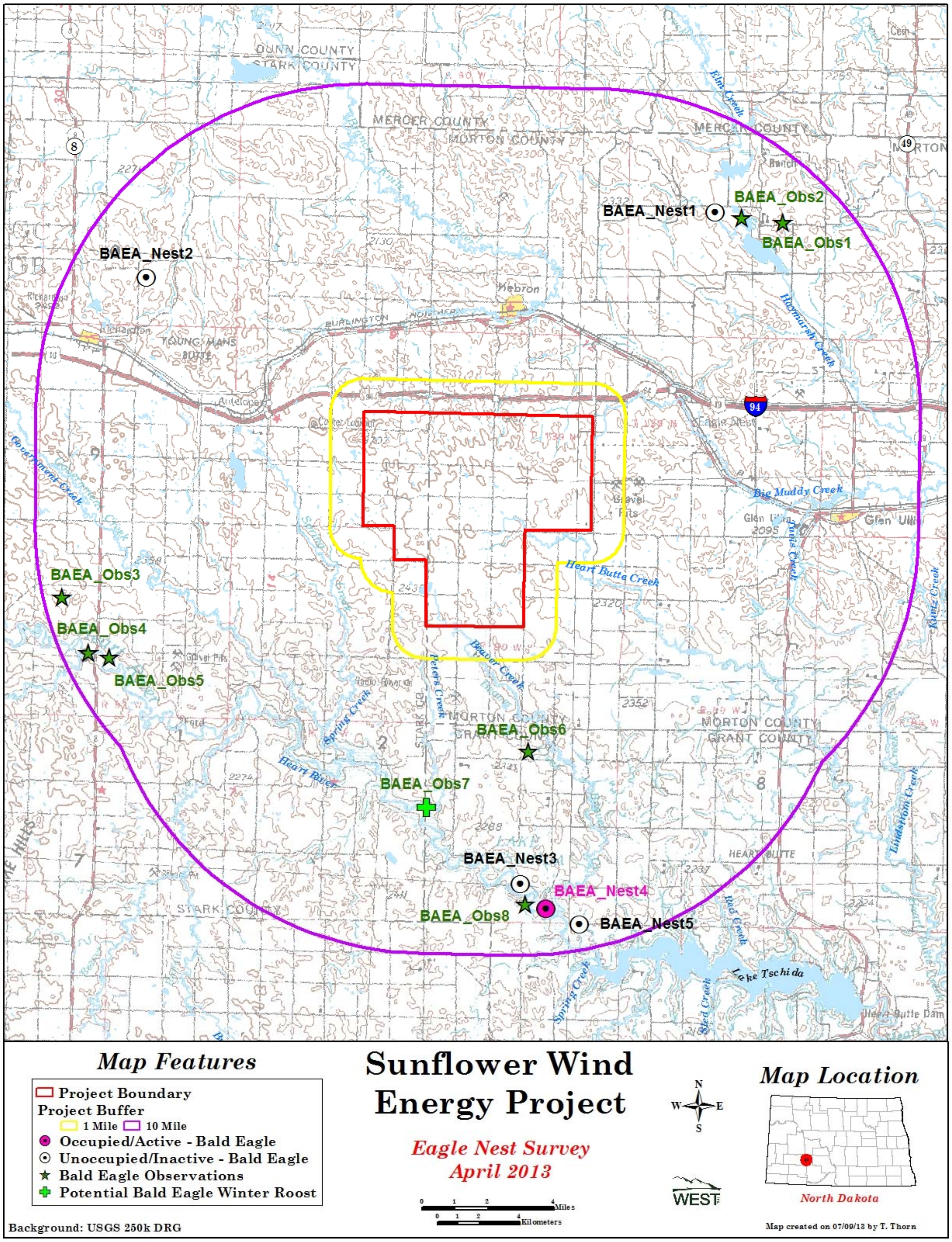

Figure 1. Bald eagle nests and bald eagle incidental observations documented at the Sunflower Wind Energy Project and 10-mile buffer in spring 2013.

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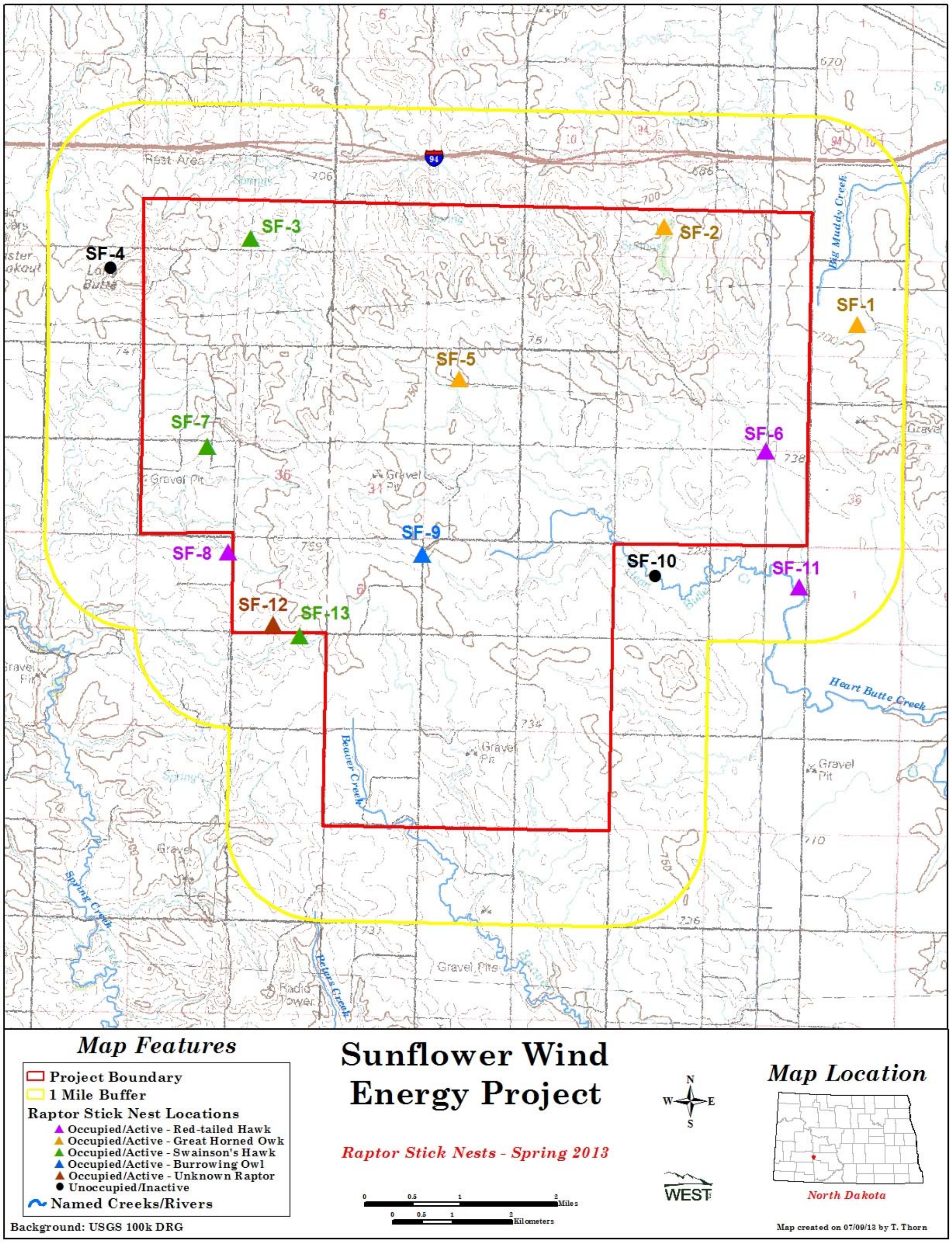

Figure 2. Raptor nests documented at the Sunflower Wind Energy Project in spring 2013.

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Table 1. Bald eagle nests and potential bald eagle nests identified during the 2013 survey for the Sunflower Wind Energy Project (NAD83, Zone 13).

Unique ID	Northing	Easting	Species	Nest Substrate	Status at time of Survey	Condition	Comments
BAEA_Nest1	5203810	734794	Potential Bald Eagle	Tree	Unoccupied – inactive	Good	Very large nest, eagle activity in the area
BAEA_Nest2	5198996	707105	Potential Bald Eagle	Tree	Unoccupied – inactive	Good	Very large nest with potential to be used by an eagle
BAEA_Nest3	5170347	727116	Potential Bald Eagle	Tree	Unoccupied – inactive	Good	Very large nest, eagle activity in the area
BAEA_Nest4	5169145	728457	Bald Eagle	Tree	Historic Occupied – active	Good	One adult sitting low in nest and second perched in tree close by
BAEA_Nest5	5168496	730096	Potential Bald Eagle	Tree	Unoccupied – inactive	Fair	Three nests stacked in one tree, eagle activity in the area

Table 2. Non-eagle raptor nests identified during the 2013 survey for the Sunflower Wind Energy Project (NAD83, Zone 14).

Unique ID	Northing	Easting	Species	Nest Substrate	Status at time of Survey	Condition
SF-1	5191511	272694	Great Horned Owl	Tree	Occupied – active	Good
SF-2	5193220	269476	Great Horned Owl	Tree	Occupied – active	Good
SF-3	5193152	262521	Swainson's Hawk	Tree	Occupied – active	Good
SF-4	5192701	260147	Unknown Raptor	Tree	Unoccupied – inactive	Good
SF-5	5190730	265989	Great Horned Owl	Tree	Occupied – active	Good
SF-6	5189415	271112	Red-tailed Hawk	Tree	Occupied – active	Good
SF-7	5189679	261729	Swainson's Hawk	Tree	Occupied – active	Good
SF-8	5187890	262038	Red-tailed Hawk	Tree	Occupied – active	Good
SF-9	5187793	265302	Burrowing Owl	Ground	Occupied – active	Good
SF-10	5187352	269208	Unknown Raptor	Tree	Unoccupied – inactive	Good
SF-11	5187127	271628	Red-tailed Hawk	Tree	Occupied – active	Good
SF-12	5186667	262774	Unknown Raptor	Tree	Occupied – active	Good
SF-13	5186465	263210	Swainson's Hawk	Tree	Occupied – active	Good

Table 3. Nest density for the Sunflower Wind Energy Project, based on raptor nest surveys.

Species	# of nests within Project	# of nests within 1-mi buffer of Project	# of nests within 10-mi buffer of Project	Density: Project (# of nests/mi^2)	Density: 1-mi buffer of Project (#nests/mi^2)	Density: 10-mi buffer of Project (#nests/mi^2)
Bald Eagle – Occupied, active	0	0	1	0	0	< 0.01
Potential Bald Eagle – Unoccupied, inactive	0	0	4	0	0	0.01
Burrowing Owl	1	0	0	0.03	0	0
Great horned Owl – Occupied, active	2	1	0	0.06	0.02	0
Red-tailed hawk – Occupied, active	1	2	0	0.03	0.03	0
Swainson's hawsk – Occupied, active	2	1	0	0.06	0.02	0
Unknown raptor – Occupied, active	1	0	0	0.03	0	0
Unknown raptor – Unoccupied, inactive	0	2	0	0	0.03	0
Total	**7**	**6**	**5**	**0.21**	**0.10**	**0.01**

Table 4. Bald eagle incidental observations during 2013 nest surveys for the Sunflower Wind Energy Project (NAD83, Zone 14).

Unique ID	Northing	Easting	Comments
BAEA_Obs1	5202750	281500	1 adult and 1 2nd year juvenile eating carrion
BAEA_Obs2	5203000	279500	1 adult perched in tree
BAEA_Obs3	5185000	245750	1 adult flying
BAEA_Obs4	5182250	247000	1 adult flying
BAEA_Obs5	5182000	248000	1 2nd year juvenile flying
BAEA_Obs6	5177000	268500	1 adult perched in tree
BAEA_Obs7	5175000	263000	1 2nd year juvenile and 8 adult eagles perched in the same tree, potential winter roost site
BAEA_Obs8	5169500	268200	2 adults flying

Wildlife Baseline Studies for the Sunflower Wind Project Morton and Stark Counties, North Dakota

2013 Sharp-tailed Grouse Lek Report

Prepared for:

Sunflower Wind Project, LLC,
a subsidiary of Infinity Wind Power
3760 State St., Suite 102
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Prepared by:

Clayton Derby and Terri Thorn

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June 22, 2013

WEST Inc.
Environmental & Statistical Consultants

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc. conducted sharp-tailed grouse lek aerial surveys in April and May 2013 at the Sunflower Wind Project which is located in Morton and Stark Counties, North Dakota. This report presents results of those surveys.

Approximately 308.1 kilometers (191.5 miles) of transects were surveyed during each of three time periods (April 10-11, April 22-23, and May 6-7). Eight confirmed (birds observed in courtship behavior at the same location during more than one survey) and five possible (birds observed in courtship behavior during only one survey) leks were recorded during the three survey periods. Six confirmed and three possible leks were observed within the project boundary while two confirmed and two possible leks were recorded outside the Sunflower Wind Project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Sunflower Wind Project, LLC, a subsidiary of Infinity Wind Power (Infinity), is proposing to construct a wind energy facility in Morton and Stark Counties North Dakota referred to as the Sunflower Wind Project (SWP). Infinity contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline wildlife studies at the SWP to estimate impacts of the proposed wind energy facility on wildlife and to assist with siting turbines to minimize impacts to wildlife resources.

This report presents results of aerial sharp-tailed grouse (*Tympanuchus phasianellus*) lek surveys conducted during April and May 2013. Data includes sharp-tailed grouse lek locations, number observed, and lek status.

STUDY AREA

The SWP, currently about 21,647 acres (ac; 89 square kilometers [km^2]; 34 square miles [mi^2]) is located in west-central North Dakota and more specifically western Morton and eastern Stark Counties. The landscape within the SWP is generally flat with more rolling lands in the northern third of the project area. Historically, the SWP's landscape was dominated by grasslands but has since been converted largely to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found around farmsteads, within planted shelter belts, and along/within drainages. Wetlands are scattered throughout the SWP with many being man-made.

METHODS

The objective of the aerial sharp-tailed grouse lek survey was to determine the approximate location of sharp-tailed grouse leks and provide a general sense of sharp-tailed grouse use within and immediately adjacent to the SWP during peak lekking activity (early April through mid-May). Survey methodology was similar to that used for greater prairie chickens (*Tympanuchus cupido*) in Oklahoma (Martin and Knopf 1981) and other wind sites in North and South Dakota.

North/south running transects started 800 meters (m; 0.5 miles [mi]) outside the east/west project boundary and were placed at 400 m (0.25 mi) intervals, covering the entire SWP (Figure 1). The length of each transect varied based on the project boundary but each transect extended 800 m (0.5 mi) beyond the boundary. Each transect was flown by fixed-winged aircraft at an approximate height of 30 to 45 m (100 – 150 feet) during three separate survey periods. Surveys were conducted approximately two weeks apart and occurred during the normal sharp-tailed grouse lekking period on the Northern Plains. Surveys began between 15 minutes before sunrise and sunrise depending on cloud cover and lasted for up to 2.5 hours.

The location of any sharp-tailed grouse observed was recorded with a global positioning system (GPS) unit. The number, activity, and lek status at each location was recorded.

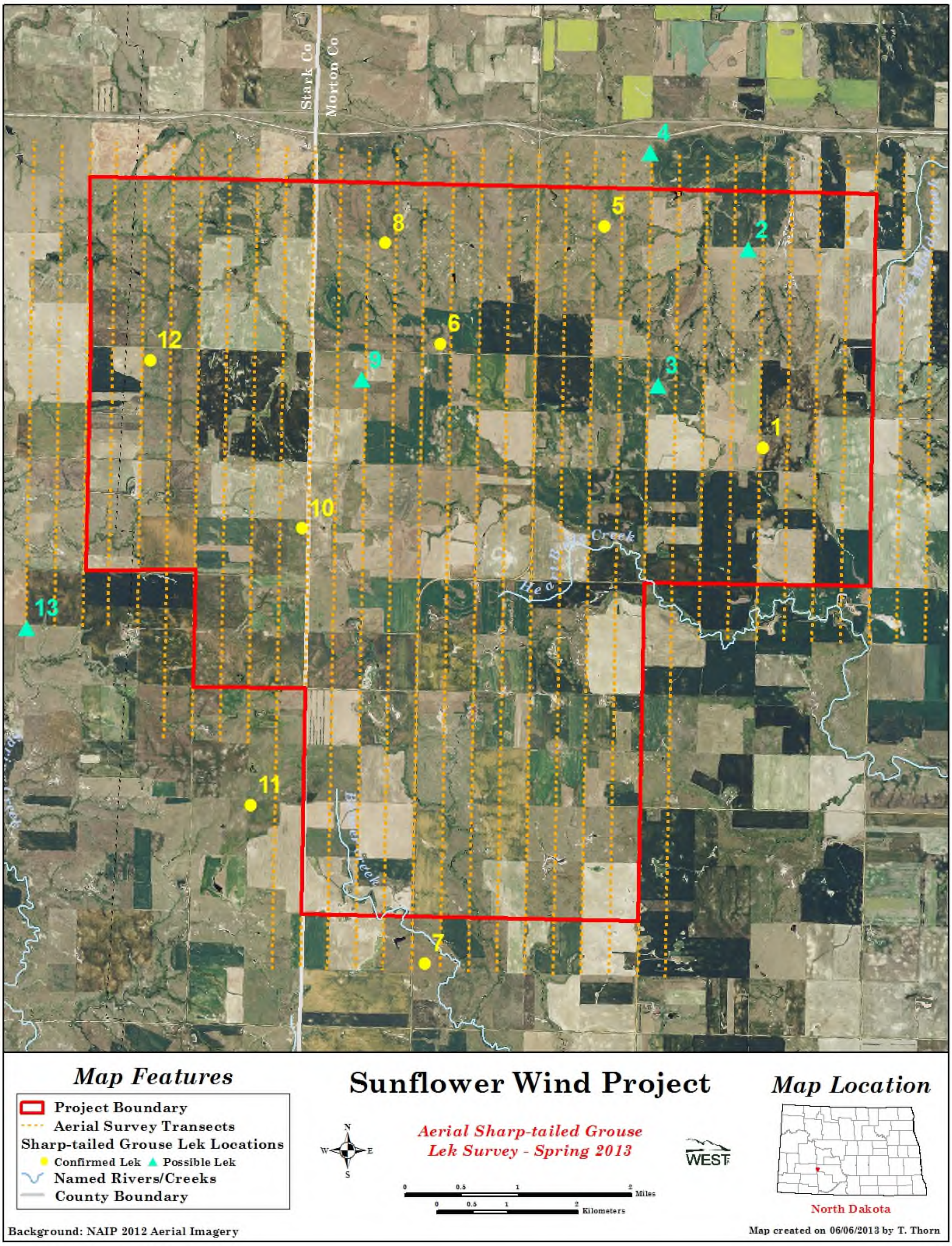

Figure 1. Sharp-tailed grouse leks at the Sunflower Wind Project during spring 2013.

RESULTS

Approximately 308.1 km (191.5 mi) of transects were surveyed during each of three time periods: (April 10-11, April 22-23, and May 6-7). Eight confirmed (birds observed in courtship behavior at the same location during more than one survey) and five possible (birds observed in courtship behavior during only one survey) leks were recorded during the three survey periods (Table 1; Figure 1). Six confirmed and three possible leks were observed within the project boundary while two confirmed and two possible leks were recorded outside the SWP (Figure 1). The nine leks within the SWP yields a density of one lek per 3.8 mi^2. The maximum number of sharp-tailed grouse record on leks ranged from seven at lek nine to 30 at lek 12 (Table 1). The majority of leks were observed within the northern half of the study area (Figure 1). All leks were recorded within grassland/hayland habitat.

Table 1. Summary of aerial sharp-tailed grouse lek surveys conducted during spring 2013 at the Sunflower Wind Project.

Lek ID	Date First Observed	Other Dates Observed	Highest Total	Lek
1	4/10	4/22, 5/06	21	confirmed
2	4/10		12	possible
3	4/10		14	possible
4	4/22		8	possible
5	4/10	4/22, 5/06	8	confirmed
6	4/10	4/22	9	confirmed
7	4/22	5/06	18	confirmed
8	4/10	4/22	16	confirmed
9	4/22		7	possible
10	4/11	4/23, 5/07	25	confirmed
11	4/11	4/23, 5/07	29	confirmed
12	4/11	4/23, 5/07	30	confirmed
13	5/07		18	possible

DISCUSSION

The majority of the SWP was lightly snow covered during the first survey period. The SWP was heavily snow covered during the second survey period due to a major winter storm on April 13th and 14th. It did not appear that snow cover, even significant snow cover, deterred sharp-tailed grouse from mating activities as evidenced by the number of leks initially observed or confirmed during the first two survey periods (Table 1).

Considering the preferred habitat requirements of sharp-tailed grouse, it is not surprising that the majority of leks were found within or adjacent to short grass habitat. This habitat type is found mainly along the north and west side of the study area. This survey was not intended to estimate the sharp-tailed grouse population in and around the SWP but the relative large number of birds recorded at some leks (30 at lek 12, 29 at lek 11, and 25 at lek 10) may suggest a healthy sharp-tailed grouse population within the area.

REFERENCES

Martin, S.A. and F.L. Knopf. 1981. Aerial Survey of Greater Prairie Chicken Leks. Wildlife Society Bulletin 9(3): 219-221.

Wildlife Baseline Studies for the Sunflower Wind Resource Area Morton and Stark Counties, North Dakota

FPIC Interim Report

March 2013 – August 2013

Prepared for:

Sunflower Wind Project, LLC

a subsidiary of Infinity Wind Power
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Prepared by:

Clayton Derby, Terri Thorn, and Kimberly Bay

Western EcoSystems Technology, Inc.
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November 8, 2013

EXECUTIVE SUMMARY

Sunflower Wind Project, LLC, (Sunflower) a subsidiary of Infinity Wind Power, has proposed a wind energy facility in Morton and Stark Counties, North Dakota, referred to as the Sunflower Wind Project (SFWP). Sunflower contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources in the SFWP to estimate the impacts of facility construction and operations on wildlife. The following seasonal interim report contains results for fixed-point bird use surveys and incidental wildlife observations. Seasonal interim reports are designed to give Infinity an early warning of high wildlife use or if sensitive species are observed within the study area.

Fixed-point surveys included in this report were conducted from March 20, 2013, through August 21, 2013, at 10 points established throughout the SFWP. A total of 152 60-minute (min) fixed-point surveys were completed, and 65 unique bird species were identified; a total of 5,792 individual birds within 1,247 separate groups were recorded.

Passerines were the most abundant bird type observed, accounting for 84.2% of all observations. This was primarily due to relatively high numbers of Lapland longspurs (1,530 individuals but in only two groups). Waterbirds, represented almost entirely by sandhill cranes, were the second most abundant bird type observed in the study area, representing 6.1% of all observations. A total of 79 diurnal raptors were observed, accounting for 1.4% of all individuals recorded. Northern harrier and Swainson’s hawk were the most commonly observed raptor species (20 and 19 individuals, respectively). Two individual bald eagles were observed in the spring.

One bald eagle was observed from fixed-point two, soaring in a southeasterly direction for eight min before it was lost from sight. The other bald eagle observation was recorded flying into the survey plot at fixed-point one from the south. It remained perched on a transmission line tower for the remaining seven min of the 60-min survey period.

There were no federally listed endangered, threaten or candidate species observed. Sixteen unique sensitive species totaling 248 individuals were recorded during all surveys at the SFWP. Six North Dakota Level I sensitive species were observed along with 10 North Dakota Level II sensitive species.

Fourteen unique bird species and four unidentified bird categories were observed incidentally, totaling 958 birds within 69 separate groups during the study. Three species, tundra swan, prairie falcon, and Say’s phoebe, were only seen incidentally at the SFWP. Six mammal and one amphibian species were also recorded incidentally at the SFWP. Two North Dakota State Level I sensitive species (Swainson’s hawk and upland sandpiper) were recorded incidentally within the project area.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In 2013, Sunflower Wind Project, LLC (Sunflower), a subsidiary of Infinity Wind Power, contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys and monitor wildlife resources for the Sunflower Wind Project (SFWP) to estimate the impacts of wind energy facility construction and operations on wildlife. The following document contains results for fixed-point bird use surveys and incidental wildlife observations during spring and summer 2013 at the SFWP.

The purpose of this interim report is to bring items of biological interest to Sunflower's attention, such as seasonal diurnal raptor use and the presence of sensitive species. This interim report presents preliminary data on number of observations by species and bird type, eagle use, and sensitive species observations. The final report will include results for all data collected.

STUDY AREA

The SFWP is located in Morton and Stark Counties, North Dakota, approximately three miles (4.8 kilometers [km]) south of the town of Hebron (Figure 1). The baseline wildlife surveys included a 21,947 acre area (ac; 89 square kilometers [km^2]; 34 square miles [mi^2]) located in west-central North Dakota and more specifically western Morton and eastern Stark Counties. The SFWP project itself would be located on approximately 9,000 acres. The landscape within the SWP is generally flat with more rolling lands in the northern third of the project area. Elevation ranges from 679 meters (m; 2,228 feet [ft]) to 817 m (2,679 ft). Historically, the SFWP's landscape was dominated by grasslands, but has since been converted largely to agricultural use with crop production and livestock grazing being the primary practices. Trees and shrubs can be found around farmsteads, within planted shelter belts, and along/within drainages. Wetlands are scattered throughout the SFWP, with many being man-made.

Cultivated cropland and herbaceous/pasture/hay lands are approximately equal in amount and compose almost 95% of the study area. Of the remaining 5%, 3.5% is developed, while wetlands, forest, and barren lands, in that order, make up the rest of the landscape (USGS NLCD 2006, Fry et al. 2011). Common agricultural crops include small grains, corn (*Zea mays*), sunflowers (*Helianthus annuus*), and alfalfa (*Medigo sativa*).

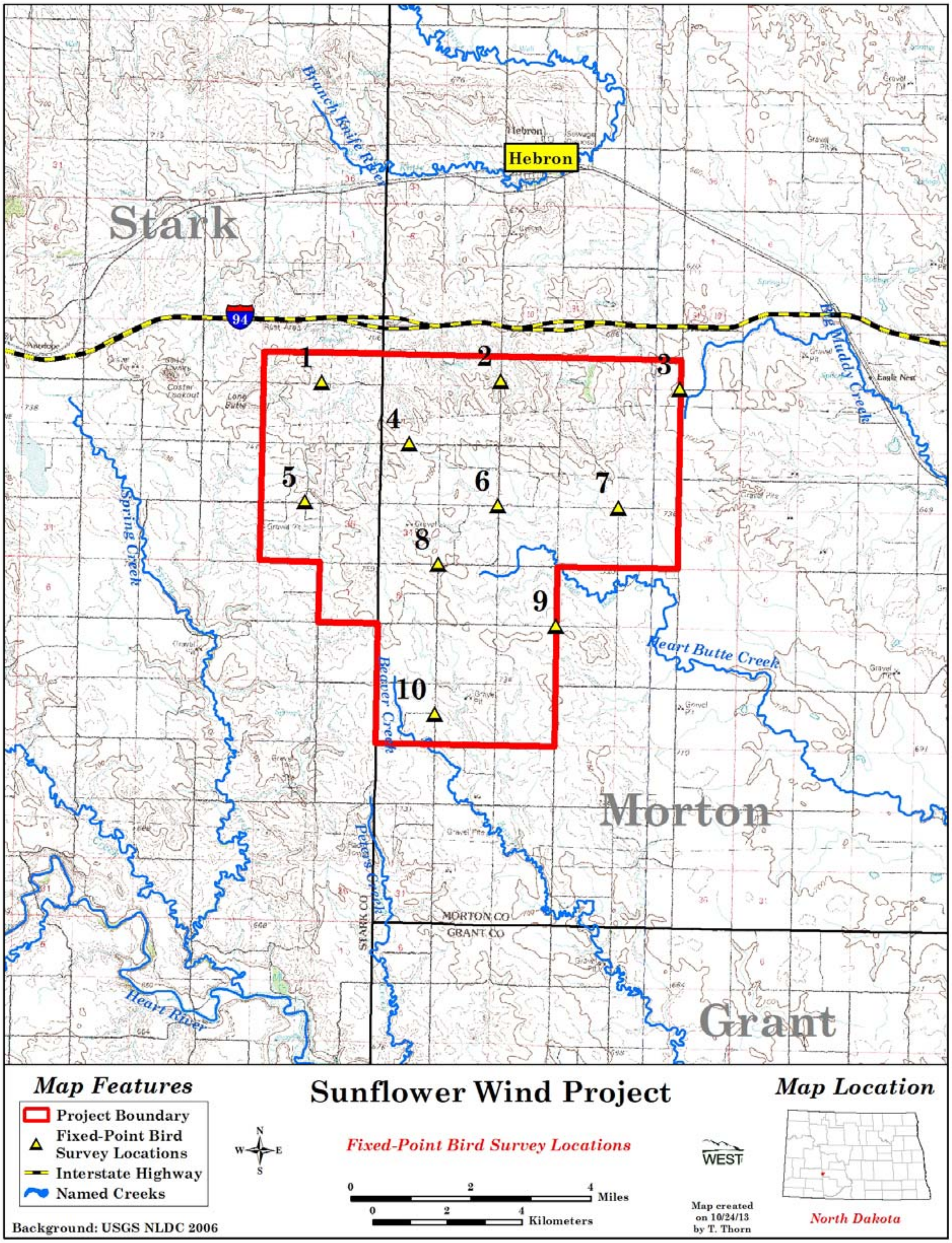

Figure 1. Fixed-point bird survey locations at the Sunflower Wind Project.

METHODS

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the study area by birds, particularly diurnal raptors (defined here as kites, accipiters, buteos, harriers, eagles, falcons, and osprey). Fixed-point bird surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980).

Survey Plots

Ten points were selected to survey representative habitats and topography of the SFWP, while achieving relatively even coverage of the study area (Figure 1). Each survey plot was a 1,600-m (5,250-ft or 1-mile) radius circle centered on the point.

Survey Methods

Each survey plot was surveyed for 60 minutes (min). Every bird observed during the first 20 min of each fixed-point bird use survey was recorded by a unique observation number. In some cases, the tally of observations may represent repeated sightings of the same individual. Observations of large birds beyond a 800-m (2,625-ft) radius were recorded, but were not included in statistical analyses. For small birds, observations beyond a 100 m (328 ft) radius were excluded. Large birds included waterbirds, waterfowl, rails and coots, grebes and loons, gulls and terns, shorebirds, diurnal raptors, owls, vultures, upland game birds, doves/pigeons, and large corvids (e.g., ravens, magpies, and crows), and goatsuckers. Passerines (excluding large corvids), kingfishers, swifts/hummingbirds, woodpeckers, and most cuckoos were considered small birds. During the next 40 min of the survey period, only eagles were recorded out to the 1,600-m radius.

The date, start and end time of the survey period, and weather information (e.g., temperature, wind speed, wind direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. Bird behavior and habitat type were recorded based on the point of first observation. Approximate flight height and distance from plot center at first observation were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only and the 10-min interval of the 20-min survey in which it was first observed. Eagle observations had distance from observer, activity and flight height recorded by minute for as long as they were observed within 60-min survey period. Flight direction was recorded on the field map.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Fixed-point bird use surveys were conducted from March 2013 through August 2013. Surveys were conducted approximately once per week during the spring (March through May) and every other week during the summer (June through August). Surveys were carried out during daylight hours and survey periods varied to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed roughly the same number of times.

Incidental Wildlife Observations

Incidental wildlife observations provide records of wildlife seen outside of the standardized surveys. All diurnal raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded in a similar fashion to standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species) and habitat were recorded. The location of sensitive species was recorded by reference to site specific features and/or by Universal Transverse Mercator (UTM) coordinates using a hand-held Global Positioning System (GPS) unit.

RESULTS

Surveys were completed within the SFWP from March 20, 2013, through August 21, 2013. Sixty-eight unique bird species, six mammal species, and one amphibian species were identified during the wildlife studies at the SFWP.

Fixed-Point Bird Use Surveys

A total of 152 60-min fixed-point bird use surveys were conducted within SFWP during 17 visits from March to August, 2013. Ninety-eight fixed-point surveys were conducted in the spring during 11 visits, while 54 fixed-point surveys were conducted in summer through August 21 during six visits. Not all point count locations were accessible during all surveys due to road conditions.

Sixty-five unique bird species were observed during fixed-point bird use surveys; a total of 5,792 individual birds were observed within 1,247 separate groups (defined as one or more individual) during the fixed-point surveys (Table 1). Passerines were the most abundant bird type observed, accounting for 84.2% of all observations. This was primarily due to relatively high numbers of Lapland longspurs (*Calcarius lapponicus*; 1,530 individuals but in only two groups). This species represents almost one-third of all passerines observed, but less than 1% of passerine groups recorded. Other common observed passerine species include common redpoll (*Acanthis flammea*; 642 individuals in 19 groups), horned lark (*Eremophila alpestris*; 627 individuals in 191 groups), and red-winged blackbirds (*Agelaius phoeniceus*; 653 individuals in 120 groups). Waterbirds, represented almost entirely by sandhill cranes (*Grus canadensis*), were the second most abundant bird type observed in the study area, representing 6.1% of all observations. A total of 79 diurnal raptors were observed, accounting for 1.4% of all individuals recorded. Northern harrier (*Circus cyaneus*) and Swainson's hawk (*Buteo swainsoni*) were the most commonly observed raptor species (20 and 19 individuals, respectively; Table 1). Two individual bald eagles (*Haliaeetus leucocephalus*) were observed in the spring (Table 1).

One bald eagle was observed from fixed-point two, soaring in a southeasterly direction for eight min before it was lost from sight. The other bald eagle observation was recorded flying into the survey plot at fixed-point one from the south. It remained perched on a transmission line tower for the remaining seven min of the 60-min survey period.

Table 1. Summary of group and individual observations by species and bird type for summer, fall, and overall seasons during fixed-point bird use surveys at the Sunflower Wind Project[a] from March 20, 2013, to August 21, 2013.

		Spring		Summer		Overall	
Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**2**	**352**	**0**	**0**	**2**	**352**
sandhill crane	*Grus canadensis*	1	350	0	0	1	350
unidentified waterbird		1	2	0	0	1	2
Waterfowl		**53**	**115**	**6**	**9**	**59**	**124**
blue-winged teal	*Anas discors*	1	2	0	0	1	2
Canada goose	*Branta canadensis*	22	53	1	1	23	54
gadwall	*Anas strepera*	1	4	0	0	1	4
mallard	*Anas platyrhynchos*	15	26	2	2	17	28
northern pintail	*Anas acuta*	4	8	1	1	5	9
northern shoveler	*Anas clypeata*	0	0	1	1	1	1
redhead	*Aythya americana*	1	2	0	0	1	2
unidentified duck		9	20	1	4	10	24
Shorebirds		**36**	**67**	**20**	**46**	**56**	**113**
Common snipe	*Gallinago gallinago*	2	2	0	0	2	2
killdeer	*Charadrius vociferus*	13	15	10	35	23	50
marbled godwit	*Limosa fedoa*	1	2	1	1	2	3
unidentified shorebird		6	22	0	0	6	22
upland sandpiper	*Bartramia longicauda*	6	6	8	9	14	15
willet	*Catoptrophorus semipalmatus*	4	14	0	0	4	14
Wilson's snipe	*Gallinago delicata*	4	6	1	1	5	7
Diurnal Raptors		**52**	**58**	**17**	**21**	**69**	**79**
Accipiters		*1*	*1*	*0*	*0*	*1*	*1*
sharp-shinned hawk	*Accipiter striatus*	1	1	0	0	1	1
Buteos		*21*	*25*	*9*	*11*	*30*	*36*
red-tailed hawk	*Buteo jamaicensis*	11	12	3	3	14	15
rough-legged hawk	*Buteo lagopus*	2	2	0	0	2	2
Swainson's hawk	*Buteo swainsoni*	8	11	6	8	14	19
Northern Harrier		*16*	*17*	*3*	*3*	*19*	*20*
northern harrier	*Circus cyaneus*	16	17	3	3	19	20
Eagles		*2*	*2*	*0*	*0*	*2*	*2*
bald eagle	*Haliaeetus leucocephalus*	2	2	0	0	2	2
Falcons		*1*	*1*	*0*	*0*	*1*	*1*
American kestrel	*Falco sparverius*	1	1	0	0	1	1
Other Raptors		*11*	*12*	*5*	*7*	*16*	*19*
unidentified hawk		3	3	0	0	3	3
unidentified raptor		8	9	5	7	13	16
Owls		**5**	**7**	**4**	**7**	**9**	**14**
burrowing owl	*Athene cunicularia*	3	5	4	7	7	12
great horned owl	*Bubo virginianus*	2	2	0	0	2	2
Vultures		**3**	**5**	**1**	**1**	**4**	**6**
turkey vulture	*Cathartes aura*	3	5	1	1	4	6

Table 1. Summary of group and individual observations by species and bird type for summer, fall, and overall seasons during fixed-point bird use surveys at the Sunflower Wind Project[a] from March 20, 2013, to August 21, 2013.

		Spring		Summer		Overall	
Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Upland Game Birds		**87**	**129**	**10**	**10**	**97**	**139**
ring-necked pheasant	*Phasianus colchicus*	80	90	10	10	90	100
sharp-tailed grouse	*Tympanuchus phasianellus*	7	39	0	0	7	39
Doves/Pigeons		**24**	**38**	**20**	**29**	**44**	**67**
mourning dove	*Zenaida macroura*	22	35	20	29	42	64
rock pigeon	*Columba livia*	2	3	0	0	2	3
Large Corvids		**6**	**10**	**0**	**0**	**6**	**10**
American crow	*Corvus brachyrhynchos*	6	10	0	0	6	10
Passerines		**679**	**4548**	**211**	**327**	**890**	**4875**
American goldfinch	*Spinus tristis*	0	0	1	1	1	1
American robin	*Turdus migratorius*	22	61	3	3	25	64
American tree sparrow	*Spizella arborea*	4	36	0	0	4	36
bank swallow	*Riparia riparia*	0	0	1	2	1	2
barn swallow	*Hirundo rustica*	8	14	6	19	14	33
bobolink	*Dolichonyx oryzivorus*	12	25	4	4	16	29
Brewer's blackbird	*Euphagus cyanocephalus*	7	24	1	4	8	28
brown-headed cowbird	*Molothrus ater*	58	288	9	15	67	303
brown thrasher	*Toxostoma rufum*	0	0	2	2	2	2
chipping sparrow	*Spizella passerina*	3	3	1	1	4	4
clay-colored sparrow	*Spizella pallida*	4	4	1	1	5	5
cliff swallow	*Petrochelidon pyrrhonota*	0	0	1	2	1	2
common grackle	*Quiscalus quiscula*	15	40	9	12	24	52
common redpoll	*Acanthis flammea*	19	642	0	0	19	642
eastern kingbird	*Tyrannus tyrannus*	7	7	31	43	38	50
European starling	*Sturnus vulgaris*	4	81	1	27	5	108
field sparrow	*Spizella pusilla*	1	1	0	0	1	1
grasshopper sparrow	*Ammodramus savannarum*	3	4	3	3	6	7
horned lark	*Eremophila alpestris*	169	586	22	41	191	627
Lapland longspur	*Calcarius lapponicus*	2	1530	0	0	2	1530
lark bunting	*Calamospiza melanocorys*	1	2	9	11	10	13
loggerhead shrike	*Lanius ludovicianus*	1	1	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	87	611	33	42	120	653
Savannah sparrow	*Passerculus sandwichensis*	13	20	9	10	22	30
snow bunting	*Plectrophenax nivalis*	2	48	0	0	2	48
song sparrow	*Melospiza melodia*	8	10	0	0	8	10
unidentified blackbird		0	0	2	3	2	3
unidentified bluebird		2	2	0	0	2	2
unidentified passerine		14	249	2	3	16	252
unidentified sparrow		11	12	2	2	13	14
vesper sparrow	*Pooecetes gramineus*	3	3	7	8	10	11
western kingbird	*Tyrannus verticalis*	7	12	15	30	22	42
western meadowlark	*Sturnella neglecta*	190	227	35	37	225	264
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	1	4	0	0	1	4
yellow warbler	*Setophaga petechia*	1	1	1	1	2	2
Goatsuckers		**0**	**0**	**1**	**1**	**1**	**1**
common nighthawk	*Chordeiles minor*	0	0	1	1	1	1

Table 1. Summary of group and individual observations by species and bird type for summer, fall, and overall seasons during fixed-point bird use surveys at the Sunflower Wind Project[a] from March 20, 2013, to August 21, 2013.

		Spring		Summer		Overall	
Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Woodpeckers		**7**	**7**	**1**	**3**	**8**	**10**
hairy woodpecker	*Picoides villosus*	1	1	0	0	1	1
northern flicker	*Colaptes auratus*	5	5	1	3	6	8
red-headed woodpecker	*Melanerpes erythrocephalus*	1	1	0	0	1	1
Unidentified Birds		**2**	**2**	**0**	**0**	**2**	**2**
unidentified bird (small)		2	2	0	0	2	2
Total		**956**	**5,338**	**291**	**454**	**1247**	**5,792**

[a] regardless of distance from observer.

Sensitive Species Observations

Sixteen unique sensitive species totaling 248 individuals were recorded during all surveys at the SFWP (Table 2). This tally may represent repeated observations of the same individual. There were no federally listed endangered, threaten or candidate species recorded. Six North Dakota Level I sensitive species (defined as species with declining status either in North Dakota or across their range) were observed, along with 10 North Dakota Level II sensitive species (defined as species with moderate level of conservation priority; Hagen et al. 2005; Table 2). Bald eagles are also protected under the Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 2. Summary of sensitive species observed at the Sunflower Wind Project during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from March 20, 2013, to August 21, 2013.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
sharp-tailed grouse	*Tympanuchus phasianellus*	S2	7	39	7	30	14	69
northern harrier	*Circus cyaneus*	S2	19	20	9	13	28	33
Swainson's hawk	*Buteo swainsoni*	S1	14	19	8	13	22	32
bobolink	*Dolichonyx oryzivorus*	S2	16	29	0	0	16	29
upland sandpiper	*Bartramia longicauda*	S1	14	15	1	3	15	18
willet	*Catoptrophorus semipalmatus*	S1	4	14	0	0	4	14
burrowing owl	*Athene cunicularia*	S2	7	12	1	1	8	13
lark bunting	*Calamospiza melanocorys*	S1	10	13	0	0	10	13
northern pintail	*Anas acuta*	S2	5	9	0	0	5	9
grasshopper sparrow	*Ammodramus savannarum*	S1	6	7	0	0	6	7
marbled godwit	*Limosa fedoa*	S1	2	3	0	0	2	3
loggerhead shrike	*Lanius ludovicianus*	S2	1	1	1	1	2	2
bald eagle	*Haliaeetus leucocephalus*	S2; EA	2	2	0	0	2	2
redhead	*Aythya americana*	S2	1	2	0	0	1	2
prairie falcon	*Falco mexicanus*	S2	0	0	1	1	1	1
red-headed woodpecker	*Melanerpes erythrocephalus*	S2	1	1	0	0	1	1
Total	**16 species**		**109**	**186**	**28**	**62**	**137**	**248**

S1 = Level I state species of concern (Hagen et al. 2005); S2 = Level II state species of concern (Hagen et al. 2005); EA = Federal Bald and Golden Eagle Protection Act (BGEPA 1940).

Incidental Wildlife Observations

Fourteen unique bird species and four unidentified bird categories were observed incidentally, totaling 958 birds within 69 separate groups during the study (Table 3). Over two-thirds of the total observations were of sandhill cranes. Three species, tundra swan (*Cygnus columbianus*), prairie falcon (*Falco mexicanus*), and Say's phoebe (*Sayornis saya*), were only seen incidentally at the SFWP. Six mammal and one amphibian species were also recorded incidentally at the SFWP (Table 3). Two North Dakota State Level I sensitive species (Swainson's hawk and upland sandpiper [*Bartramia longicauda*]) were recorded incidentally within the project (Table 2).

Table 3. Incidental wildlife observed while conducting all surveys at the Sunflower Wind Project from March 20, 2013, to August 21, 2013.

Species	Scientific Name	# grps	# obs
sandhill crane	*Grus canadensis*	9	654
tundra swan	*Cygnus columbianus*	1	2
upland sandpiper	*Bartramia longicauda*	1	3
American kestrel	*Falco sparverius*	6	7
northern harrier	*Circus cyaneus*	9	13
prairie falcon	*Falco mexicanus*	1	1
red-tailed hawk	*Buteo jamaicensis*	12	14
Swainson's hawk	*Buteo swainsoni*	8	13
unidentified accipiter		1	1
unidentified hawk		2	5
unidentified raptor		3	4
burrowing owl	*Athene cunicularia*	1	1
turkey vulture	*Cathartes aura*	4	6
gray partridge	*Perdix perdix*	1	2
sharp-tailed grouse	*Tympanuchus phasianellus*	7	30
loggerhead shrike	*Lanius ludovicianus*	1	1
Say's phoebe	*Sayornis saya*	1	1
unidentified crowned sparrow		1	200
Bird Subtotal		**69**	**958**
coyote	*Canis latrans*	3	3
mule deer	*Odocoileus hemionus*	1	5
porcupine	*Erethizon dorsatum*	2	2
pronghorn	*Antilocapra americana*	11	57
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	4	8
white-tailed jackrabbit	*Lepus townsendii*	1	1
Mammal Subtotal		**22**	**76**
western chorus frog	*Pseudacris triserata triseriata*	2	20
Amphibian Subtotal		**2**	**20**

DISCUSSION

The surveys implemented at SFWP during spring and summer of 2013 are part of a larger study effort. Seasonal interim reports are designed to give Infinity an early warning if high wildlife use is documented during surveys or if a sensitive species is observed.

Bird Use Surveys

Species diversity of birds observed reflected the grassland and agricultural habitat within the SFWP. Species of open grassland habitats were dominant, but species that utilize woodlands and wetlands were also observed interspersed within the study area.

By far, the spring season had the higher number of bird observations (5,338) compared to summer (454). Although the spring season had almost twice as many surveys conducted, it is unlikely that doubling the number of surveys in summer would have resulted in the total number of birds observed to approach those recorded in spring. Lapland longspur and common redpoll had the highest number of individuals recorded and were only observed in the spring. In total, there were 26 bird species that were recorded in spring that were not recorded in the summer, while there were only four species that were observed in the summer that were not recorded in the spring.

Overall, diurnal raptors were also more common in the spring; birds observed during the spring probably included migrating individuals. The Swainson’s hawk was the most abundant diurnal raptor recorded during the summer (Table 1).

Comparison of Seasonal Diurnal Raptor Use

Diurnal raptors have received much attention due to high rates of fatalities at the Altamont Pass wind energy facility in California, which has the highest recorded overall diurnal raptor fatality rate of any wind energy facility (Erickson et al. 2002b). Based on the results from other wind resource areas, mean diurnal raptor use (number of diurnal raptors divided by the number of 800-m plots and the total number of surveys) in the SFWP during both the spring and summer of 2013 was low to moderate (0.53 and 0.35 diurnal raptors/plot/20 min survey, respectively) relative to data collected at other existing and proposed wind energy facilities with data for spring or summer seasons (Figures 2 and 3).

Sensitive Species

No federally endangered, threatened or candidate species were recorded during surveys within the SFWP. There were six North Dakota Level I and 10 Level II sensitive species recorded. Two State Level II bald eagles were observed during fixed-point surveys. Bald eagles are also legally protected under the Bald and Golden Eagle Protection Act (BGEPA 1940).

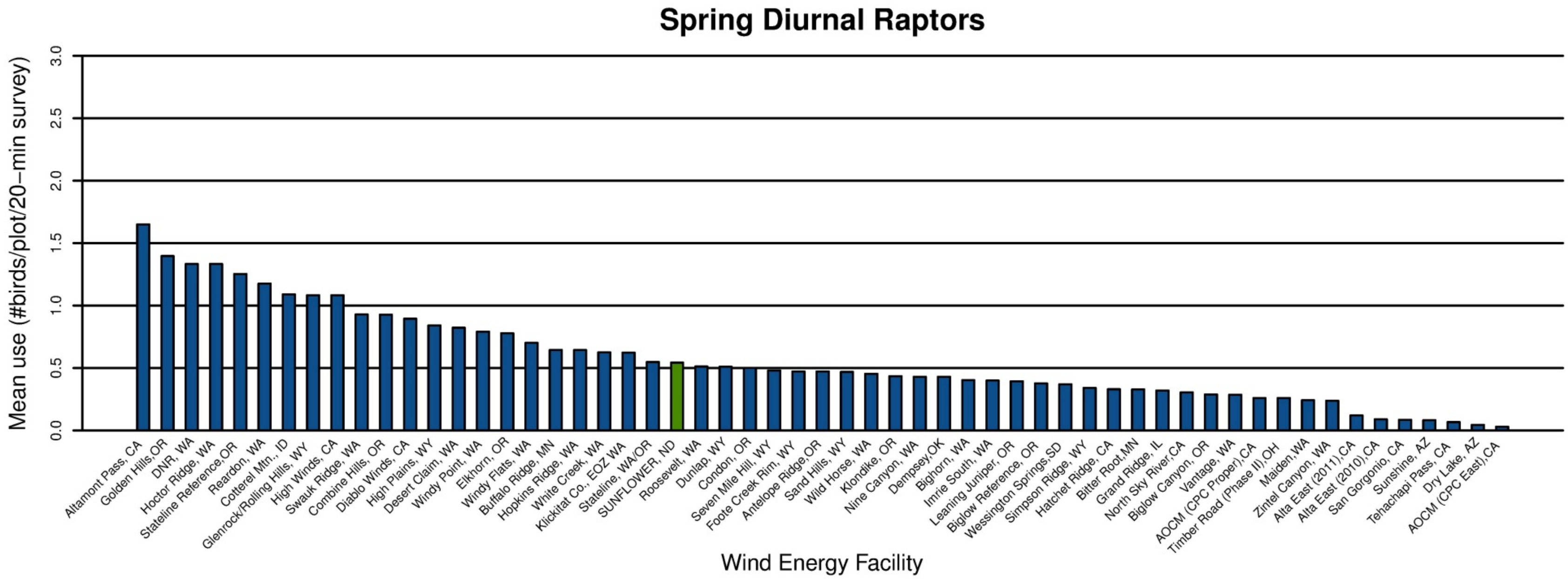

Figure 2. Comparison of spring diurnal raptor use during fixed-point surveys at the Sunflower Wind Project from March 20, 2013, to August 21, 2013, and other US wind energy facilities.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Sunflower Wind Project, ND	This study.				
Altamont Pass, CA	Orloff and Flannery 1992	White Creek, WA	NWC and WEST 2004	Simpson Ridge, WY	Johnson et al. 2000b
Golden Hills, OR	Jeffrey et al. 2008	Klickitat Co., EOZ WA	WEST and NWC 2003	Hatchet Ridge, CA	Young et al. 2007a
DNR, WA	Johnson et al. 2006c	Stateline, WA/OR	Erickson et al. 2003a	Bitter Root, MN	Derby and Dahl 2009
Hoctor Ridge, WA	Johnson et al. 2006d	Roosevelt, WA	NWC and WEST 2004	Grand Ridge, IL	Derby et al. 2009
Stateline Reference, OR	URS et al. 2001	Dunlap, WY	Johnson et al. 2009a	North Sky River, CA	Erickson et al. 2011
Reardon, WA	WEST 2005b	Condon, OR	Erickson et al. 2002b	Biglow Canyon, OR	WEST 2005c
Cotterel Mtn., ID	BLM 2006	Seven Mile Hill, WY	Johnson et al. 2008b	Vantage, WA	WEST 2007
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Foote Creek Rim, WY	Johnson et al. 2000b	AOCM (CPC Proper), CA	Chatfield et al. 2010
High Winds, CA	Kerlinger et al. 2005	Antelope Ridge, OR	WEST 2009	Timber Road (Phase II), OH	Good et al. 2010
Swauk Ridge, WA	Erickson et al. 2003b	Sand Hills, WY	Johnson et al. 2006a	Maiden, WA	Young et al. 2002
Combine Hills, OR	Young et al. 2003c	Wild Horse, WA	Erickson et al. 2003d	Zintel Canyon, WA	Erickson et al. 2002a, 2003c
Diablo Winds, CA	WEST 2006	Klondike, OR	Johnson et al. 2002	Alta East (2011), CA	Chatfield et al. 2011
High Plains, WY	Johnson et al. 2009b	Nine Canyon, WA	Erickson et al. 2001	Alta East (2010), CA	Chatfield et al. 2011
Desert Claim, WA	Young et al. 2003b	Dempsey, OK	Derby et al. 2010	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
Windy Point, WA	Johnson et al. 2006b	Bighorn, WA	Johnson and Erickson 2004	Sunshine, AZ	WEST and the CPRS 2006
Elkhorn, OR	WEST 2005a	Imrie South, WA	Johnson et al. 2006e	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Windy Flats, WA	Johnson et al. 2007b	Leaning Juniper, OR	Kronner et al. 2005	Dry Lake, AZ	Young et al. 2007b
Buffalo Ridge, MN	Johnson et al. 2000a	Biglow Reference, OR	WEST 2005c	AOCM (CPC East), CA	Chatfield et al. 2010
Hopkins Ridge, WA	Young et al. 2003a	Wessington Springs, SD	Derby et al. 2008		

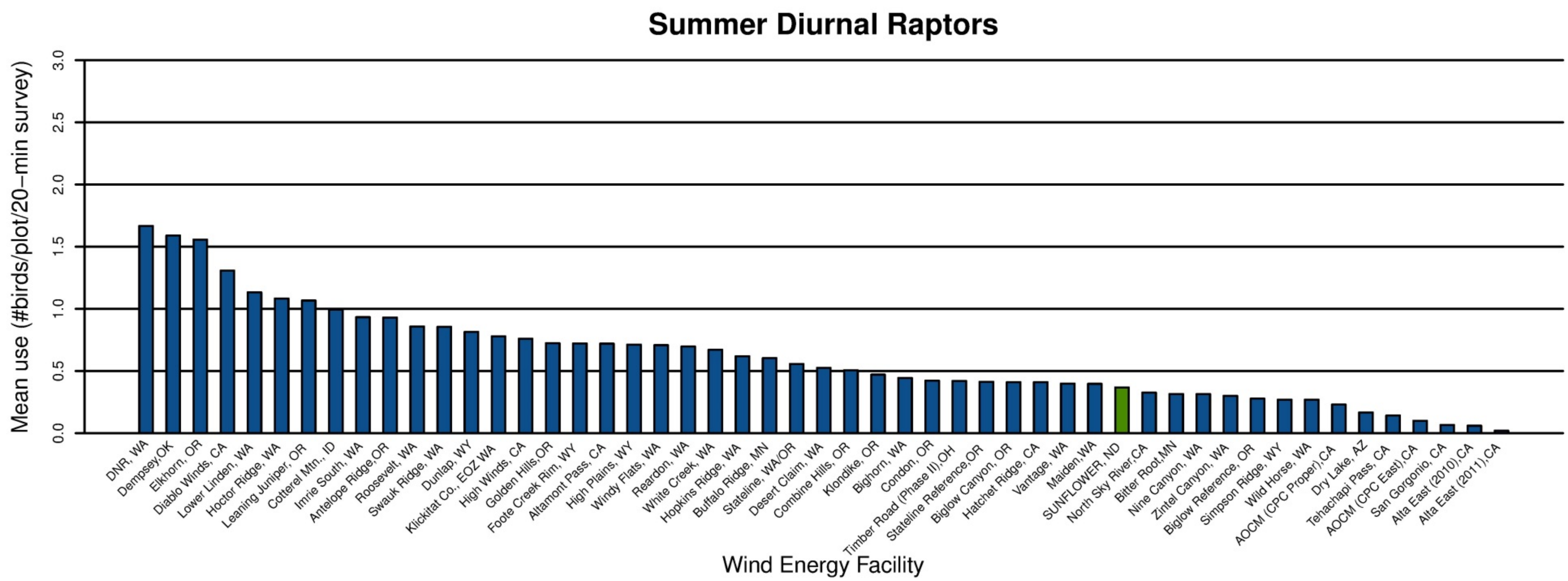

Figure 3. Comparison of summer diurnal raptor use during fixed-point surveys at the Sunflower Wind Project from March 20, 2013, to August 21, 2013, and other US wind energy facilities.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference	Study and Location	Reference
Sunflower Wind Project, ND	This study.				
DNR, WA	Johnson et al. 2006c	Altamont Pass, CA	Orloff and Flannery 1992	Vantage, WA	WEST 2007
Dempsey, OK	Derby et al. 2010	High Plains, WY	Johnson et al. 2009b	Maiden, WA	Young et al. 2002
Elkhorn, OR	WEST 2005a	Windy Flats, WA	Johnson et al. 2007b	North Sky River, CA	Erickson et al. 2011
Diablo Winds, CA	WEST 2006	Reardon, WA	WEST 2005b	Bitter Root, MN	Derby and Dahl 2009
Lower Linden, WA	Johnson et al. 2007a	White Creek, WA	NWC and WEST 2005	Nine Canyon, WA	Erickson et al. 2001
Hoctor Ridge, WA	Johnson et al. 2006d	Hopkins Ridge, WA	Young et al. 2003a	Zintel Canyon, WA	Erickson et al. 2002a, 2003c
Leaning Juniper, OR	Kronner et al. 2005	Buffalo Ridge, MN	Johnson et al. 2000a	Biglow Reference, OR	WEST 2005c
Cotterel Mtn., ID	BLM 2006	Stateline, WA/OR	Erickson et al. 2003a	Simpson Ridge, WY	Johnson et al. 2000b
Imrie South, WA	Johnson et al. 2006e	Desert Claim, WA	Young et al. 2003b	Wild Horse, WA	Erickson et al. 2003d
Antelope Ridge, OR	WEST 2009	Combine Hills, OR	Young et al. 2003c	AOCM (CPC Proper), CA	Chatfield et al. 2010
Roosevelt, WA	NWC and WEST 2004	Klondike, OR	Johnson et al. 2002	Dry Lake, AZ	Young et al. 2007b
Swauk Ridge, WA	Erickson et al. 2003b	Bighorn, WA	Johnson and Erickson 2004	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Dunlap, WY	Johnson et al. 2009a	Condon, OR	Erickson et al. 2002b	AOCM (CPC East), CA	Chatfield et al. 2010
Klickitat Co., EOZ WA	WEST and NWC 2003	Timber Road (Phase II), OH	Good et al. 2010	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
High Winds, CA	Kerlinger et al. 2005	Stateline Reference, OR	URS et al. 2001	Alta East (2010), CA	Chatfield et al. 2011
Golden Hills, OR	Jeffrey et al. 2008	Biglow Canyon, OR	WEST 2005c	Alta East (2011), CA	Chatfield et al. 2011
Foote Creek Rim, WY	Johnson et al. 2000b	Hatchet Ridge, CA	Young et al. 2007a		

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February 11, 2014

Casey Willis
Sunflower Wind Project, LLC.
3760 State Street, Suite 102
Santa Barbara, CA 93105

RE: Sunflower Avian Use Fall and Winter Update

Dear Mr. Willis,

Western EcoSystems Technology, Inc. (WEST) was contracted to conduct avian use point counts at the proposed Sunflower project area in central North Dakota. See attached map, and corresponding point count locations currently being surveyed. Surveys started in mid-March 2013 and are continuing to date. Surveys were done weekly during the spring and fall migration periods and twice per month during the summer and winter period. Each point is surveyed for one hour during each visit.

WEST provided an interim report detailing observations and initial analysis of data from project start on March 20 through August 21, 2013. This memo updates information collected during surveys conducted between late August 2013 and early February 2014. During the fall and winter surveys to date, a total of 61 raptors observations were documented spread among seven species, including observations at all distances from the observer during point counts. The most common raptor species observed was northern harrier. One bald eagle and four golden eagles were observed during point counts. See the attached table for a complete list of species and observations made during the point counts from late August 2013 through early February 2014. The overall species and numbers appear to be reflective of a grassland landscape in central North Dakota.

Please let me know if you have any questions or need further details.

Sincerely,

Clayton Derby
Senior Manager

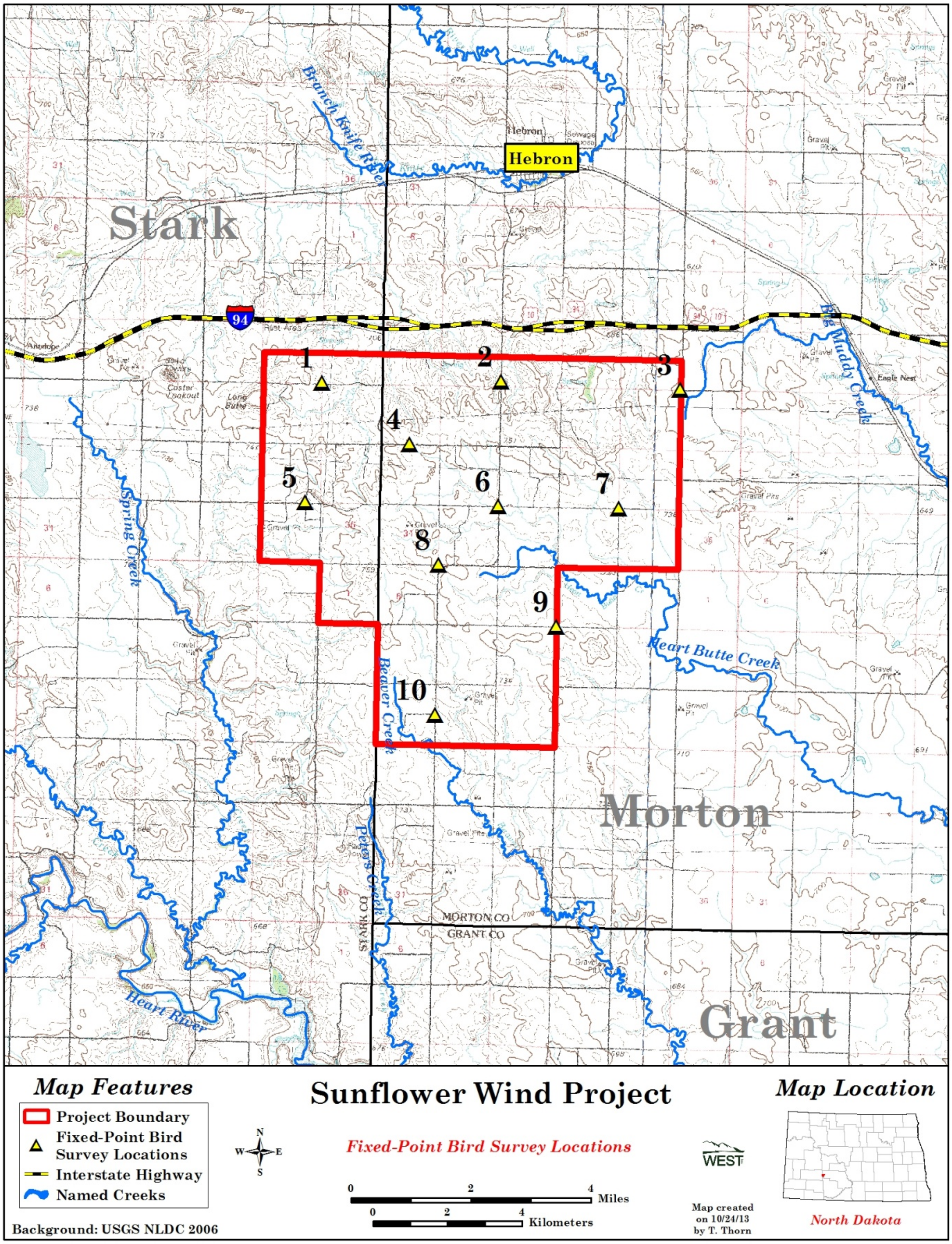

Figure 1. Avian use survey points within the Sunflower project area.

Table 1. Species observed during avian point counts within the Sunflower project area, late August 2013 through early February 2014.

Common Name	Total Observations
American Crow	1
American Goldfinch	15
American Robin	2
Bald Eagle	1
Barn Swallow	38
Black-billed Magpie	1
Brown-headed Cowbird	2
Brewer's Blackbird	30
Canada Goose	45
Clay-colored Sparrow	1
Common Grackle	10
Ferruginous Hawk	1
Golden Eagle	4
Gray Partridge	2
Greater White-fronted Goose	150
Horned Lark	216
House Sparrow	18
Killdeer	8
Lincoln's Sparrow	1
Mourning Dove	12
Northern Flicker	1
Northern Harrier	23
Rough Legged Hawk	10
Ring-necked Pheasant	102
Red-tailed Hawk	12
Rusty Blackbird	8
Red-winged Blackbird	22
Sandhill Cranes	35
Savannah Sparrow	12
Snow Bunting	97
Snow Goose	27
Sharp-tailed Grouse	26
Swainson's Hawk	10
Turkey Vulture	5
Vesper Sparrow	1
Western Meadowlark	48

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November 15, 2013

Casey Willis
Sunflower Wind Project, LLC
3760 State St., Suite 102
Santa Barbara, CA 93105

RE: Sunflower Wind Project Habitat Mapping

Dear Mr. Willis,

Vegetation types (or Habitat) were delineated using ArcGIS, ArcMap 10.1 within the Sunflower Wind Project (SFWP) and a one mile buffer (Buffer). Using 2012 USDA NAIP aerial imagery in combination with 2006 USGS NLCD land use/land cover, 2004 ND Gap land use/land cover, and 2010 and 2011 USDA NASS land classification, all land within the two areas was digitized and assigned one of seven habitat types (excluding National Wetland Inventory [NWI] wetlands; Table 1). NWI data was used to represent water within the two study areas. Those water features (mostly created stock dams and dugouts) visible on the aerial imagery but not in the NWI data were digitized as "water" habitat.

The SFWP, as described, contained slightly more than 21,980 acres and the one mile buffer contained approximately 3,000 less acres than the SFWP. Cropland and grassland made up the vast majority of land cover in both areas (96.8% of the SFWP and 93.5% of the Buffer) with cropland making up the highest percentage of both (Table 1). In descending order, the following habitat types made up the remaining area of the SFWP: developed, NWI wetlands, deciduous trees, shrubs, unknown trees, and water while the only difference in the Buffer was slightly more deciduous trees than NWI wetlands (Table 1). The percentage of each habitat type was similar between the two areas (Table 1).

Habitat types were spread out across the SFWP and Buffer (Figure 1). There was a slight predominance of larger grasslands tracts in the northern third of the SFWP and a higher amount of developed area (associated with Interstate 94) in the northern part of the Buffer (Figure 1).

Let me know if you have any questions or need further details.

Sincerely,

Clayton Derby
Senior Manager

Table 1. Digitized Land Cover within the Sunflower Wind Project and 1 mile buffer.

	SFWP		Buffer	
Habitat Type	**Acres**	**%**	**Acres**	**%**
Cropland	12,940.3	58.9	9,978.2	53.0
Grassland	8,323.8	37.9	7,619.3	40.5
Developed	485.1	2.2	967.52	5.1
NWI[a] Wetlands	110.3	0.5	104.0	0.6
Deciduous Trees	102.5	0.5	135.7	0.7
Shrubs	16.8	0.1	14.7	0.1
Unknown Trees	2.7	<0.1		
Water	1.3	<0.1	4.9	<0.1
Total	**21,982.8**		**18,824.3**	

[a] USFWS National Wetland Inventory

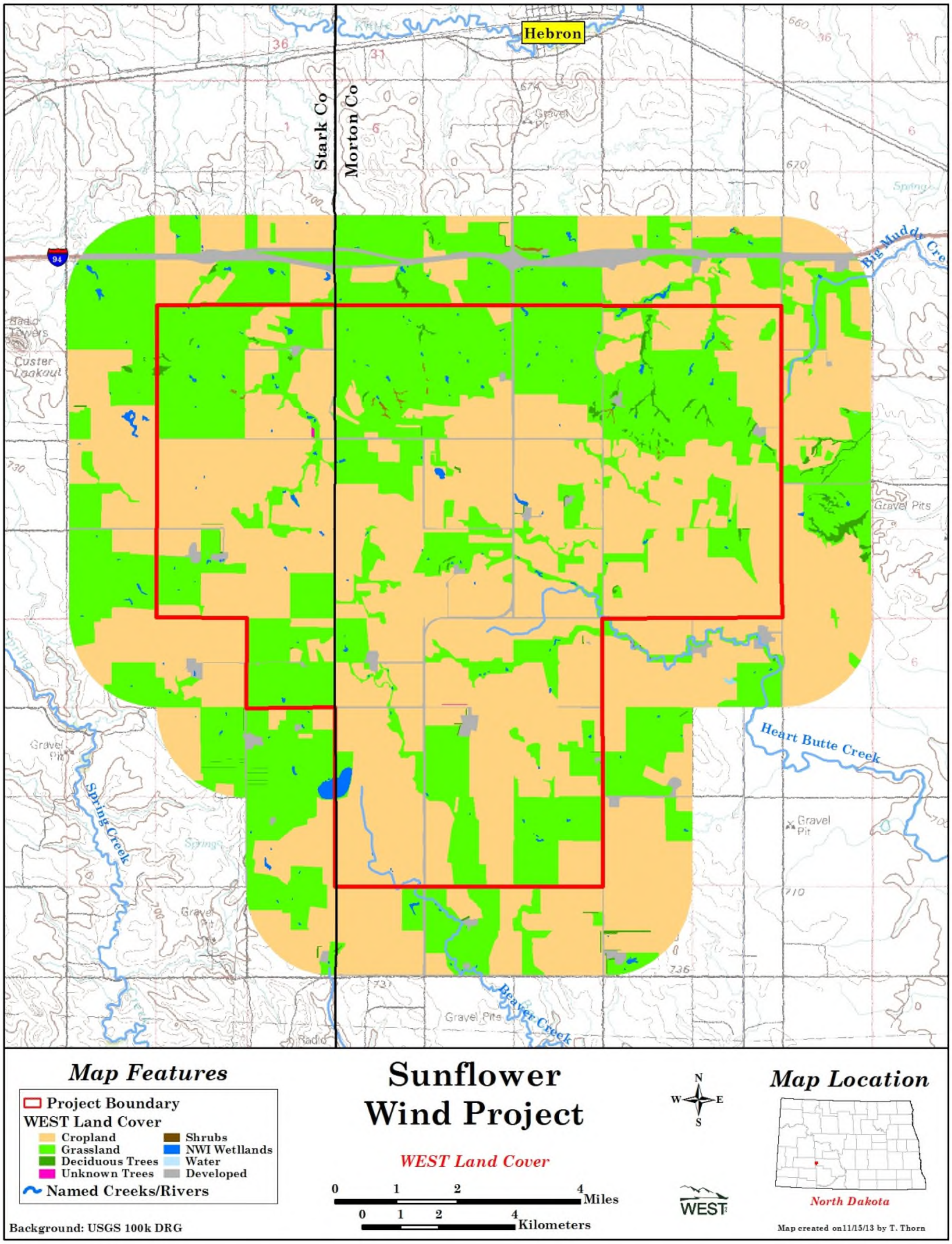

Figure 1. Digitized Land cover within the Sunflower Wind Project and 1 mile buffer.

Bat Activity Studies for the Sunflower Wind Project, Morton and Stark Counties, North Dakota

Final Report

June 2013 – October 2013

Prepared for:

Sunflower Wind Project, LLC

3760 State Street, Suite 102
Santa Barbara, California 93105

Prepared by:

Clayton Derby, Goniela Iskali, and Terri Thorn

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

December 10, 2013

EXECUTIVE SUMMARY

In June 2013, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Sunflower Wind Project (SWP) in Morton and Stark Counties, North Dakota. The bat acoustic survey conducted at the SWP was designed to estimate levels of bat activity within the SWP during summer and fall.

Acoustic surveys were conducted at three meteorological (met) tower stations in hay fields from June 12 through October 23, 2013. Four AnaBat™ SD2 detectors were utilized for the survey. Three acoustic monitoring stations were placed near the ground (one meter [m; 3.3 feet (ft)]) and one of these stations was paired with a detector unit with a microphone placed at approximately 45 m (147.6 ft) on the met tower using a modified bat-hat. All stations were monitored on a weekly or bi-monthly basis.

In total, AnaBat units recorded 537 bat passes in 477 detector-nights for a combined mean (± standard error) of 1.15 ± 0.12 bat passes per detector-night (Table 3). Ground detectors recorded 448 bat passes on 351 detector-nights for a mean of 1.30 ± 0.14 bat passes per detector-night, while the raised station recorded 89 bat passes on 126 detector nights for a mean of 0.71 ± 0.11 per detector-night.

Bat activity varied between seasons, with low activity in the summer and higher activity higher in the fall. Low-frequency bat pass rates peaked during late August, while high-frequency bat pass rates peaked during early August. Higher activity during the late summer and early fall may be due to the presence of both post-lactating adult female bats and newly volant juvenile bats as well as migrating bats.

For all detector locations, 54.6% of bat passes were classified as high-frequency (e.g., eastern red bats), while 45.4% of bat passes were classified as low-frequency (e.g., hoary bats and silver-haired bats).

Bat activity recorded at the SWP by ground detectors during the fall migration period (1.70 ± 0.20 bat passes per detector-night) was one of the lower call rates recorded when compared to all the facilities in the Midwest as well as compared with all facilities in North America which reported similarly-collected data.

STUDY PARTICIPANTS

Western EcoSystems Technology

Clayton Derby	Project Manager
Goniela Iskali	Bat Biologist and Report Compiler
Kimberly Bay	Data and Report Manager
Terri Thorn	GIS Technician
Andrea Palochak	Technical Editor
Cathy Clayton	Field Technician

REPORT REFERENCE

Derby, C., G. Iskali, and T. Thorn. 2013. Bat Activity Studies for the Sunflower Wind Project, Morton and Stark Counties, North Dakota. Final Report: June 2013 – October 2013. Prepared for Infinity Wind Power, Santa Barbara, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Sunflower Wind Project, LLC (Sunflower), a wholly owned subsidiary of Infinity Wind Power, is considering the development of a wind energy facility in the Sunflower Wind Project (SWP) in Morton and Stark Counties, North Dakota. Sunflower contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the US Fish and Wildlife Service's (USFWS) Land-Based Wind Energy Guidelines (WEG; USFWS 2012) based on methods outlined in Kunz et al. (2007a). WEST conducted acoustic monitoring surveys to estimate levels of bat activity within the SWP during summer and fall. The following report describes the results of acoustic monitoring surveys conducted at the SWP between June 12 and October 23, 2013.

STUDY AREA

The SWP is located in Morton and Stark Counties, North Dakota, approximately three miles (4.8 kilometers [km]) south of the town of Hebron (Figures 1 and 2). The SWP, currently about 21,983 acres (89 square kilometers [km^2]; 34 square miles [mi^2]) is located in west-central North Dakota, and more specifically western Morton and eastern Stark Counties. The landscape within the SWP is generally flat with more rolling lands in the northern third of the project area. Elevation ranges from 679 meters (m; 2,228 feet [ft]) to 817 m (2,679 ft). Historically, the SWP's landscape was dominated by grasslands but has since been converted largely to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found around farmsteads, within planted shelter belts, and along/within drainages. Wetlands are scattered throughout the SWP with many being man-made.

Cultivated cropland and herbaceous/pasture/hay lands are approximately equal in amount and comprise almost 95% of the study area. Of the remaining 5%, 3.5% is developed, while wetlands, forest, and barren lands, in that order, make up the rest of the landscape (Table 1; Figure 2; USGS NLCD 2006, Fry et al. 2011). Common agricultural crops include small grains, corn (*Zea mays*), sunflowers (*Helianthus annuus*), and alfalfa (*Medicago sativa*).

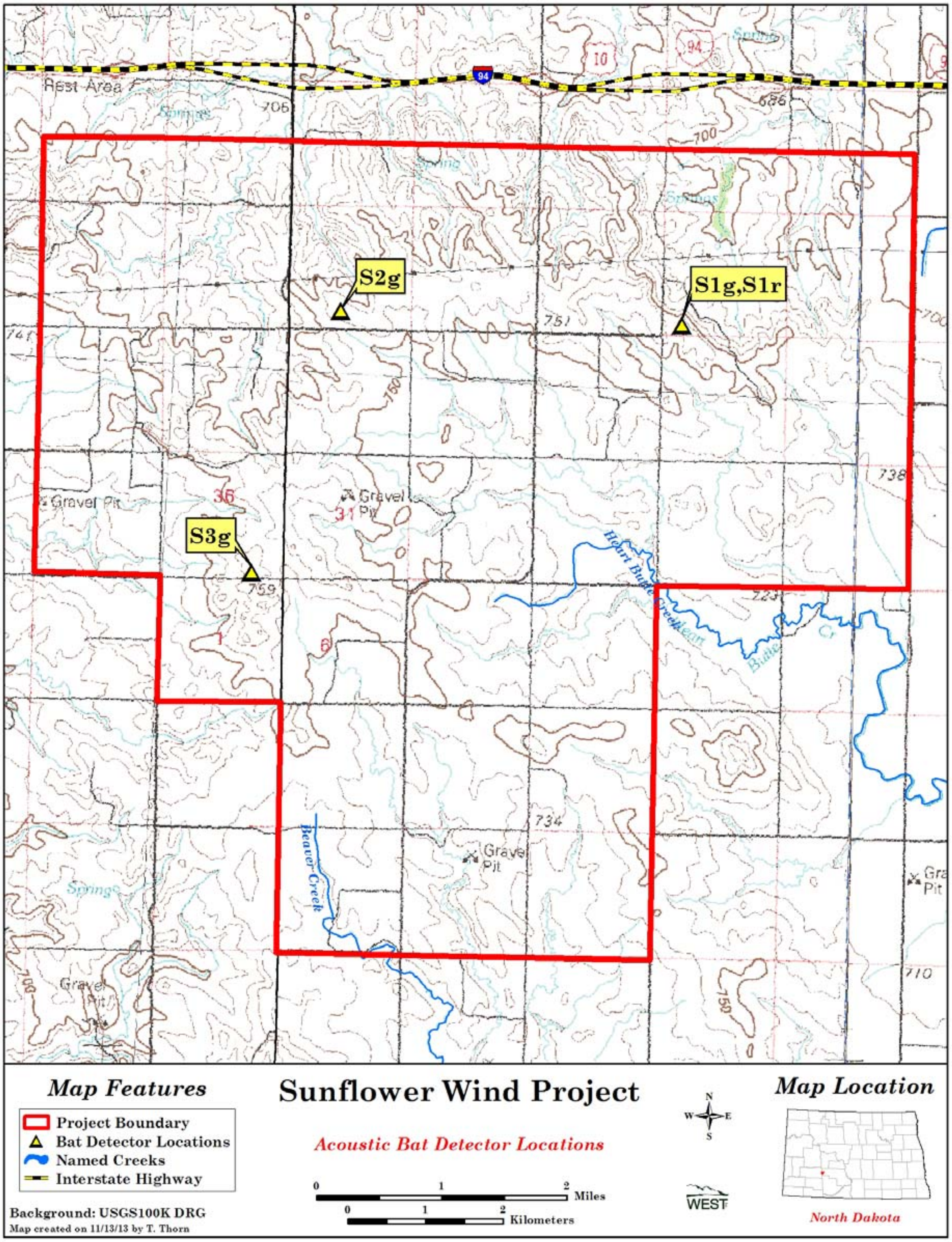

Figure 1. Topographic map showing the location of the Sunflower Wind Project and AnaBat stations.

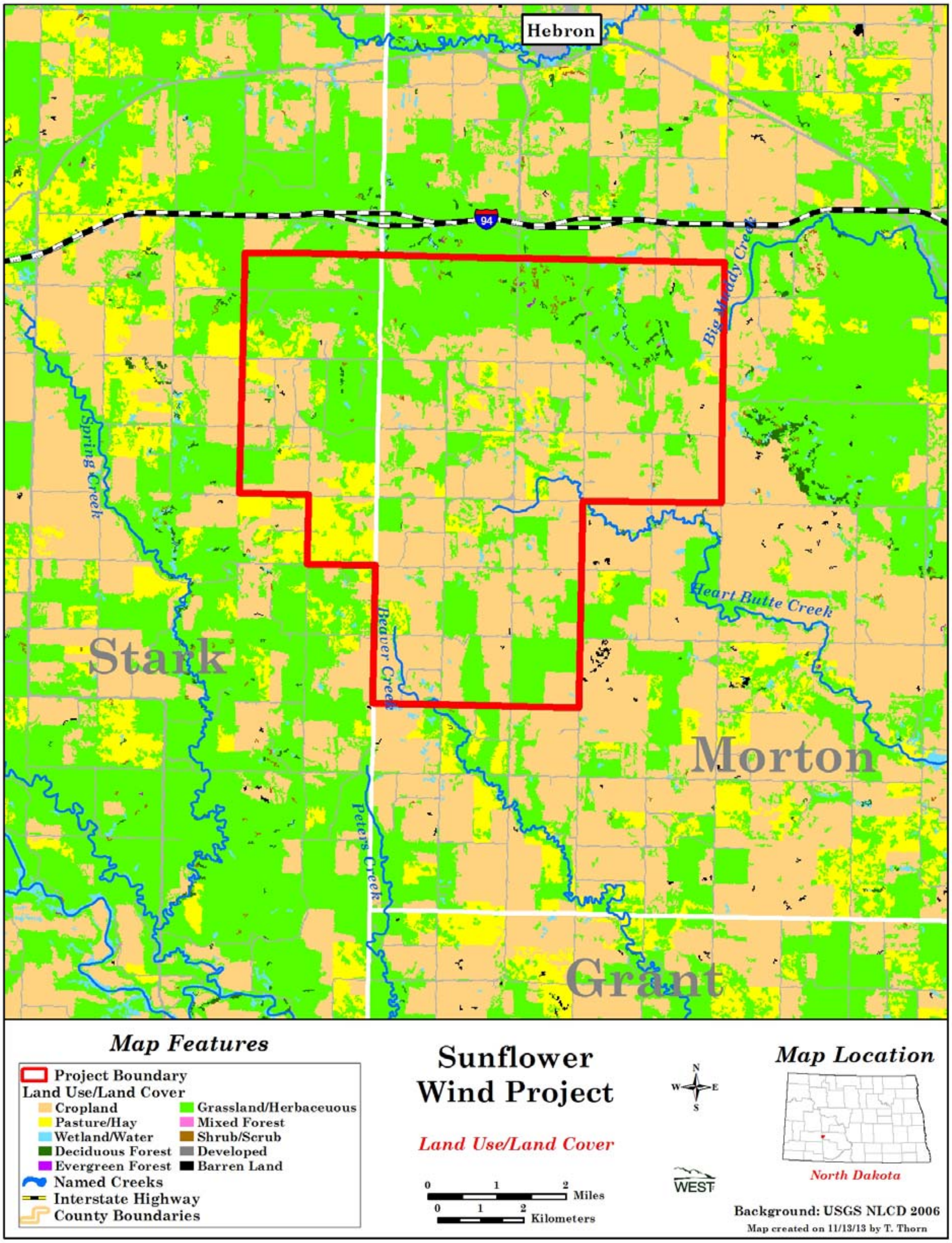

Figure 2. Land cover in the Sunflower Wind Project (USGS NLCD 2006).

Table 1. Land cover in the Sunflower Wind Project according to the United States Geological Survey National Land Cover Dataset (USGS NLCD 2006).

Land Cover	Acres	% Composition
Cultivated Crops	10,493.79	47.74
Grassland/Herbaceous	8,965.43	40.78
Pasture/Hay	1,394.77	6.34
Developed, Open Space	703.38	3.20
Woody Wetlands	110.59	0.50
Deciduous Forest	100.58	0.46
Shrub/Scrub	62.75	0.29
Developed, Low Intensity	58.52	0.27
Emergent Herbaceous Wetland	46.51	0.21
Open Water	30.93	0.14
Barren Land (rock/sand/clay)	8.23	0.04
Evergreen Forest	4.45	0.02
Mixed Forest	3.34	0.02
Total	**21,983.27**	**100**

Overview of Bat Diversity

Ten species of bats may potentially occur in North Dakota and in the SWP (Table 2). One of these, the northern long-eared bat, is a sensitive species that was recently proposed to be listed as endangered by the USFWS (2013). The northern long-eared bat, along with several once common and abundant bat species such as the little brown bat (*Myotis lucifugus*) are experiencing population declines due to the spread of white-nose syndrome (Frick et al. 2010; Center for Biological Diversity 2010). The northern long-eared bat uses caves and underground mines for hibernation. There are no karst regions or mines within the SWP for hibernation. The nearest karst region is approximately 130 miles from SWP and located in southeastern Montana (USGS 2013). During the summer, it relies upon forested habitat and it roosts in tree cavities and underneath exfoliating bark (BCI 2013) and forages over open water areas within and near forested areas. There are limited trees within the SWP (Figure 2); the closest area of denser tree growth around water is the Heart River, approximately 8 miles south of the SWP.

Table 2. Bat species with potential to occur within the Sunflower Wind Project (Harvey et al. 1999, BCI 2003) categorized by echolocation call frequency.

Common Name	Scientific Name
High-Frequency (> 30 kHz)	
eastern red bat[1,3]	*Lasiurus borealis*
western small-footed bat	*Myotis ciliolabrum*
little brown bat[1]	*Myotis lucifugus*
western long-eared bat[1]	*Myotis evotis*
northern long-eared bat[1,2]	*Myotis septentrionalis*
long-legged bat[1]	*Myotis volans*
Low-Frequency (< 30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
hoary bat[1,3]	*Lasiurus cinereus*
silver-haired bat[1,3]	*Lasionycteris noctivagans*
fringed bat	*Myotis thysanodes*

[1] species known to have been killed at wind energy facilities (Species reported by Anderson et al. 2004, Kunz et al. 2007b, Baerwald 2008);
[2] proposed for listing as a federally endangered species (USFWS 2013); and
[3] long-distance migrant.

METHODS

Bat Acoustic Surveys

WEST conducted acoustic monitoring studies to estimate levels of bat activity throughout the SWP during summer and fall. Bat detectors are a primary acoustic survey tool used in baseline wind development surveys to calculate an index of bat activity; the levels of bat activity provide some insight into possible impacts of development on bats (Arnett 2007, Kunz et al. 2007a).

Survey Stations

Four AnaBat™ SD2 ultrasonic bat detectors (Titley Scientific™, Australia) were used during the study. Two AnaBat SD2 detectors were paired at one of the meteorological (met) towers, with one detector at ground level approximately 1 m (3.3 ft) above ground level (AGL) and another approximately 45 m (148 ft) AGL (Figure 1). The other two AnaBat units (ground level) were placed at two other met tower locations (Figure 1). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009, Collins and Jones 2009), so it is important to monitor at different heights (Kunz et al. 2007b). Ground-based detectors likely detect a more complete sample of the bat species present within the project area, whereas elevated detectors may give a more accurate assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007b).

Each AnaBat unit was inside a plastic weather-resistant container that had a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain. Raised AnaBat microphones were elevated on met towers using a pulley system. Bat-Hat weatherproof housing (EME Systems, Berkeley California) was modified by replacing the Plexiglas reflector plate with a 45-degree angle PVC elbow. The Bat-Hat was altered because detectors protected using un-modified Bat-Hats may detect lower activity and species richness than are present at a site, while detectors protected with a 45-degree PVC elbow have been found to detect similar numbers and quality of bat calls as detectors exposed to the environment (Britzke et al. 2010).

Survey Schedule

Bats were surveyed at the SWP from June 12 to October 23, 2013, and units were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night.

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored by the detector. Incoming echolocation calls are digitally processed and stored on a high capacity compact flash card. The resulting files can be viewed in appropriate software (i.e., Analook©) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) and to identify the call frequency classification and (when possible) the species of bat that generated the calls.

The detection range of AnaBat detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the bat, atmospheric conditions; Limpens and McCracken 2004), but is generally less than 30 m (98 ft) due to atmospheric absorption of echolocation pulses (Fenton 1991). To standardize acoustic sampling effort across the project, AnaBat units were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise (Brooks and Ford 2005).

For each survey location, bat passes were sorted by their minimum frequency into two groups based on their minimum frequency that correspond roughly to species groups of interest. For example, most species of *Myotis* bats, as well as eastern red bats (*Lasiurus borealis*), echolocate at frequencies greater than 30 kilohertz (kHz), and are considered high-frequency bats (HF), whereas species such as the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*) typically emit echolocation calls below 30 kHz and are considered low-frequency bats. To establish which species may have produced passes in each category, a list of species expected to occur in the study area was compiled from range maps (Table 2; BCI 2003).

Statistical Analysis

The standard metric used for measuring bat activity was the number of bat passes per detector-night, and this metric was used as an index of bat activity in the project area. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (White and Gehrt 2001, Gannon et al. 2003). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. Bat passes per detector-night was calculated for all bats, and for HF and LF categories. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat acoustic analyst using Analook. All multi-detector averages in this report were calculated by averaging the average activity of each detector.

The period of peak sustained bat activity was defined as the 7-day period with the highest average bat activity. If multiple 7-day periods equaled the peak sustained bat activity rate, all dates in these 7-day periods were reported. This and all multi-detector averages in this report were calculated as an un-weighted average of total activity at each detector.

To highlight seasonal activity patterns, the study was divided into two survey periods: summer (June 13 – July 31), and fall (August 1 – October 23). Mean bat activity was also calculated for a standardized fall migration period (FMP), defined here as July 30 – October 14. The FMP represents the period between dissolution of maternity colonies and onset of the swarming and hibernation seasons. This period was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008).

Risk Assessment

To assess potential for bat fatalities, bat activity in the SWP was compared to existing data at other wind energy facilities in the Midwest. Among studies measuring both activity and fatality rates, most data were collected during the fall using AnaBat detectors placed at ground level near met towers. Therefore, to make valid comparisons to the publically available data, this report uses the activity rate recorded at ground detectors during the FMP as a standard for comparison with activity data from other wind energy facilities. Given the relatively small number of publicly-available studies and the significant ecological differences between geographically dispersed facilities, the risk assessment is qualitative, rather than quantitative.

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at the three sampling locations between June 12 and October 23, 2013, resulting in a total of 477 detector-nights (89.7% of the potential sampling period; Figure 3). The primary causes of lost data were weather related when excessive wind knocked down two of the AnaBat detectors, and battery failure. AnaBat units at fixed ground stations recorded 448 bat passes on 351 detector-nights for a mean (± standard error) of 1.30 ± 0.14 bat passes per detector-night, while the raised station recorded 89 bat passes on 126 detector nights for a mean of 0.71 ± 0.11 per detector-night (Table 3, Figure 4). In total, AnaBat units recorded 537 bat passes on 477 detector-nights for a mean of 1.15±0.12 bat passes per detector-night (Table

3). In addition, excessive noise was detected for about three weeks from August 13 to September 3, 2013, likely due to bee hives that were installed near station S3g (Figure 5).

Spatial Variation

Bat activity in the SWP was consistently higher at the ground units (Figure 4, Table 3). On average, activity at ground detectors (1.30 ± 0.14) was nearly twice as high as at the raised detector (0.71 ± 0.11; Table 3, Figures 4 and 6). Bat activity varied between the four met tower locations. Among ground units, S3G recorded the fewest bat passes per detector-night (0.88 ± 0.17), while unit S1G recorded the most (1.65 ± 0.19; Table 3, Figure 4).

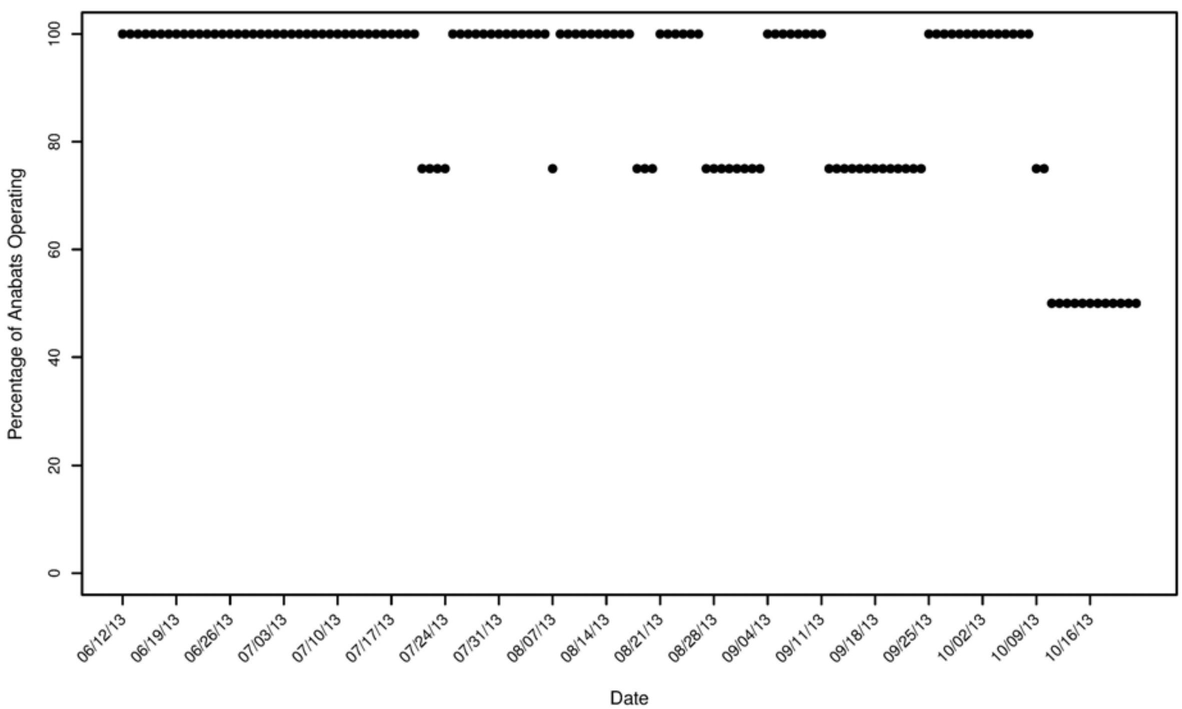

Figure 3. Operational status of AnaBat detectors operating at the Sunflower Wind Project during each night of the study period June 12 to October 23, 2013.

Table 3. Results of acoustic bat surveys conducted at fixed stations within the Sunflower Wind Project from June 12 to October 23, 2013. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

AnaBat Station	Location	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night*
S1G	ground	105	81	186	113	1.65±0.19
S1R	raised	15	74	89	126	0.71±0.10
S2G	ground	90	56	146	106	1.38±0.18
S3G	ground	83	33	116	132	0.88±0.17
Total Ground		278	170	448	351	1.30±0.14
Total Raised		15	74	89	126	0.71±0.11
Total		293	244	537	477	1.15±0.12

* ± bootstrapped standard error.

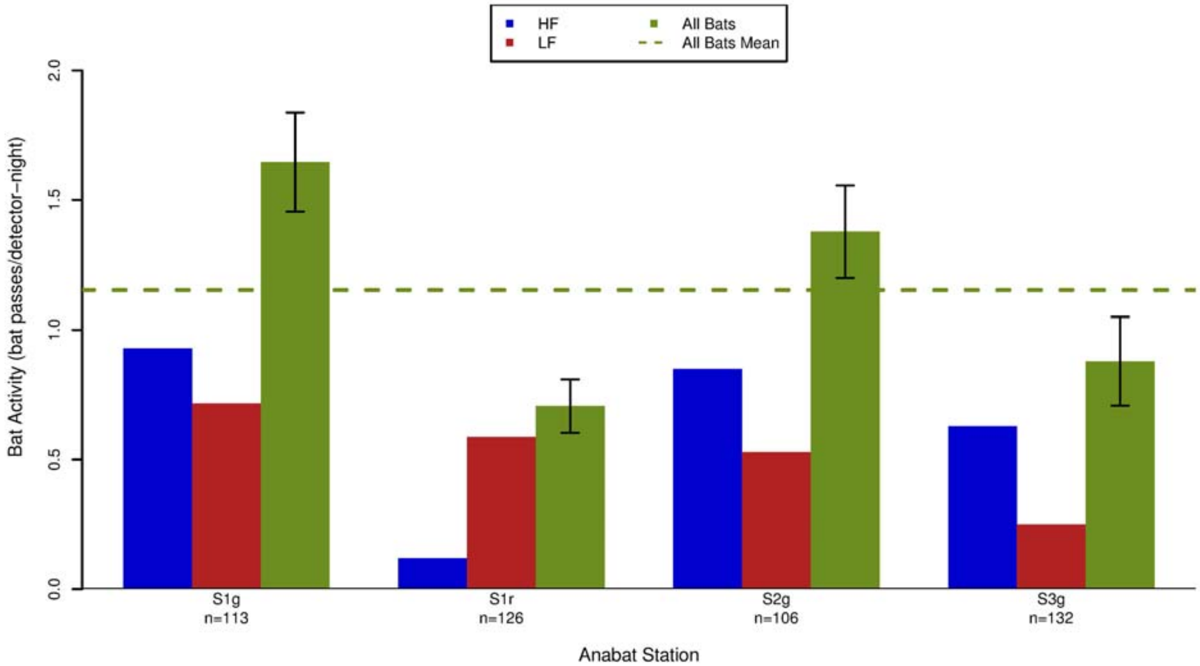

Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at AnaBat stations in the Sunflower Wind Project between June 12 to October 23, 2013. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

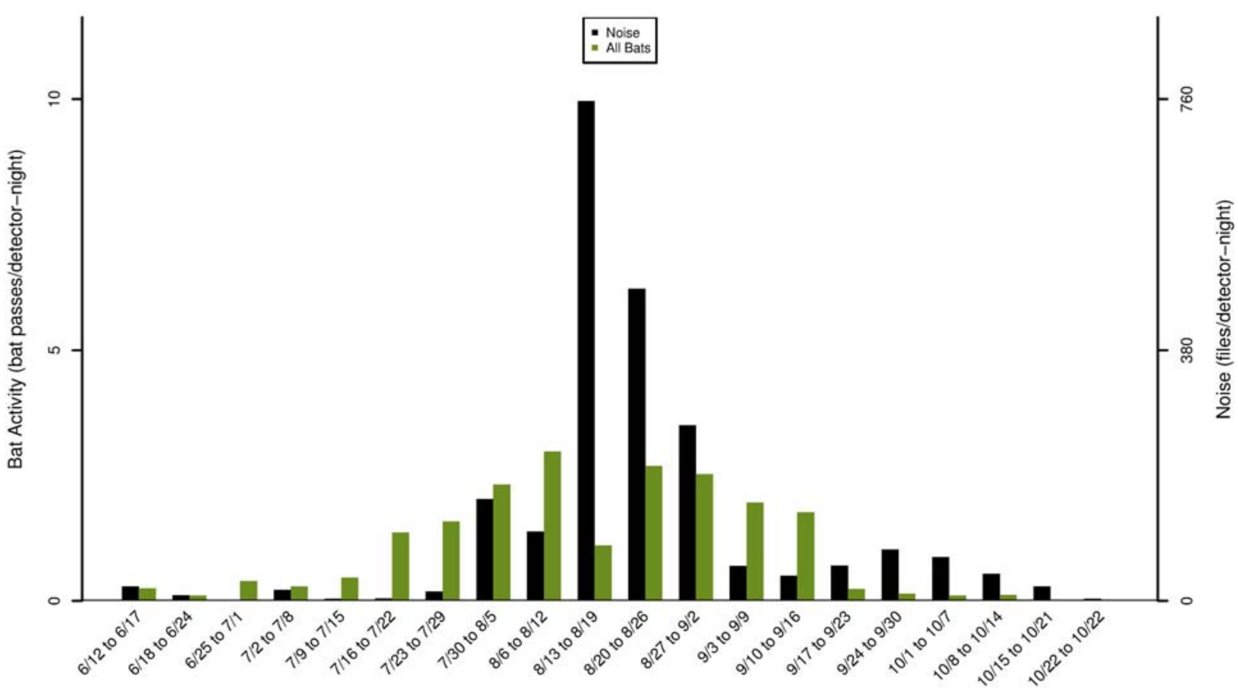

Figure 5. Activity and noise comparison at fixed AnaBat stations for all bats in the Sunflower Wind Project from June 12 to October 23, 2013.

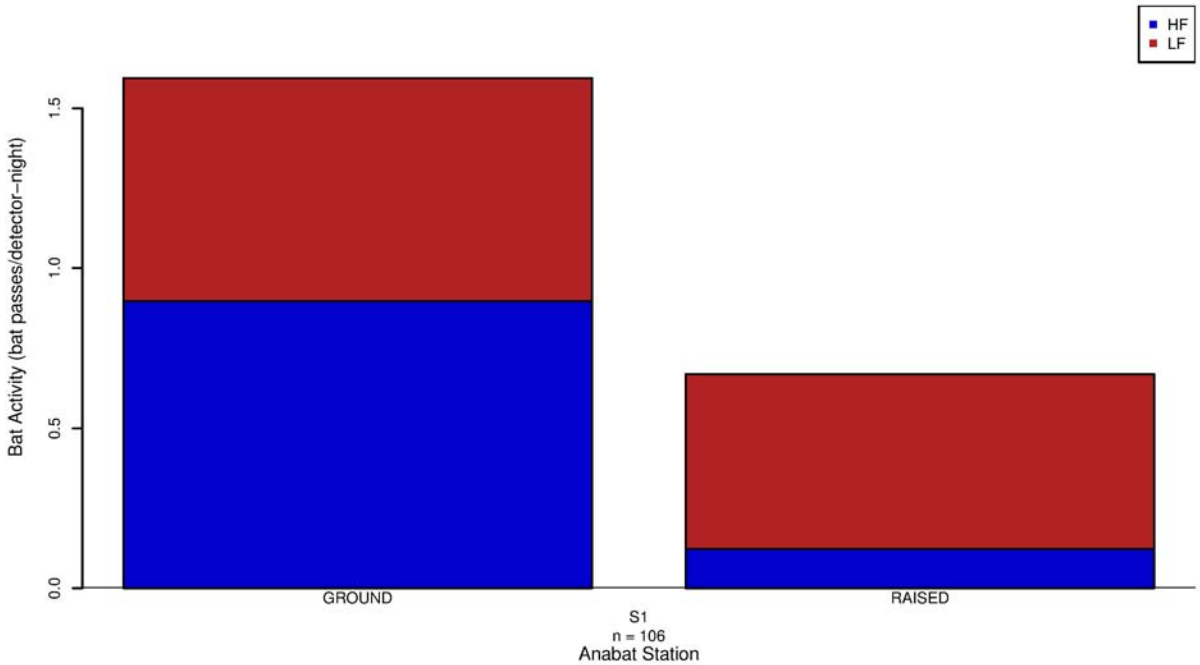

Figure 6. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at the paired AnaBat station (S1) between June 12 to October 23, 2013.

Temporal Variation

Bat activity at fixed stations was relatively low in the summer and higher in the fall (Table 4; Figure 7). Bat activity peaked from August 4 to August 10 at 3.35 bat passes per detector-night (Table 5). After the peak, overall bat activity gradually decreased for the remainder of the study period (Figure 8). Comparing weekly activity at paired ground and raised detectors indicates a subtle shift during the course of the season; activity was generally higher at ground detectors throughout the summer and fall, but LF calls were higher at the raised station during the fall and FMP (Table 4; Figure 9).

Table 4. The number of bat passes per detector-night recorded at met towers stations in the Sunflower Wind Project during each season in 2013, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Summer June 12 – Jul 31	Fall Aug 1 – Oct 23	Fall Migration Jul 30 – Oct 14
S1g	LF	0.38	0.98	1.00
	HF	0.66	1.14	1.14
	AB	1.04	2.13	2.14
S1r	LF	0.13	0.85	0.93
	HF	0.09	0.14	0.18
	AB	0.22	0.99	1.11
S2g	LF	0.18	0.84	0.83
	HF	0.74	0.95	0.95
	AB	0.92	1.79	1.78

Table 4. The number of bat passes per detector-night recorded at met towers stations in the Sunflower Wind Project during each season in 2013, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Summer June 12 – Jul 31	Fall Aug 1 – Oct 23	Fall Migration Jul 30 – Oct 14
S3g	LF	0.06	0.37	0.39
	HF	0.56	0.67	0.8
	AB	0.62	1.04	1.2
Ground Totals	**LF**	0.21±0.06	0.73±0.11	0.74±0.11
	HF	0.65±0.12	0.92±0.13	0.96±0.13
	AB	0.86±0.16	1.65±0.20	1.70±0.20
Raised Totals	**LF**	0.13±0.06	0.85±0.16	0.93±0.17
	HF	0.09±0.05	0.14±0.04	0.18±0.05
	AB	0.22±0.09	0.99±0.18	1.11±0.19
Overall	**LF**	0.19±0.04	0.76±0.11	0.79±0.11
	HF	0.51±0.09	0.72±0.10	0.77±0.10
	AB	0.70±0.12	1.48±0.18	1.55±0.18

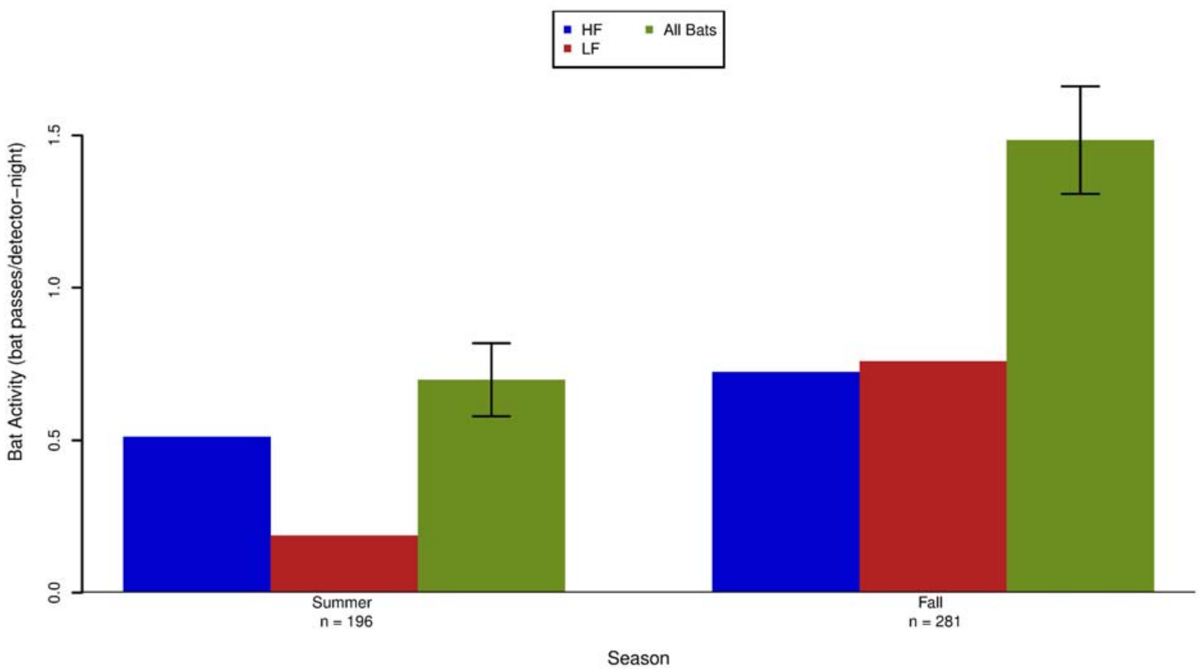

Figure 7. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Sunflower Wind Project from June 12 to October 23, 2013. The bootstrapped standard errors are represented by black bars on the 'All Bats' columns.

Table 5. Periods of peak activity for high-frequency (HF), low-frequency (LF), and all bats at the Sunflower Wind Project for the study period June 12 – October 23, 2013.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
HF	August 4	August 10	2.10
LF	August 27	September 04	1.76
All Bats	August 4	August 10	3.35

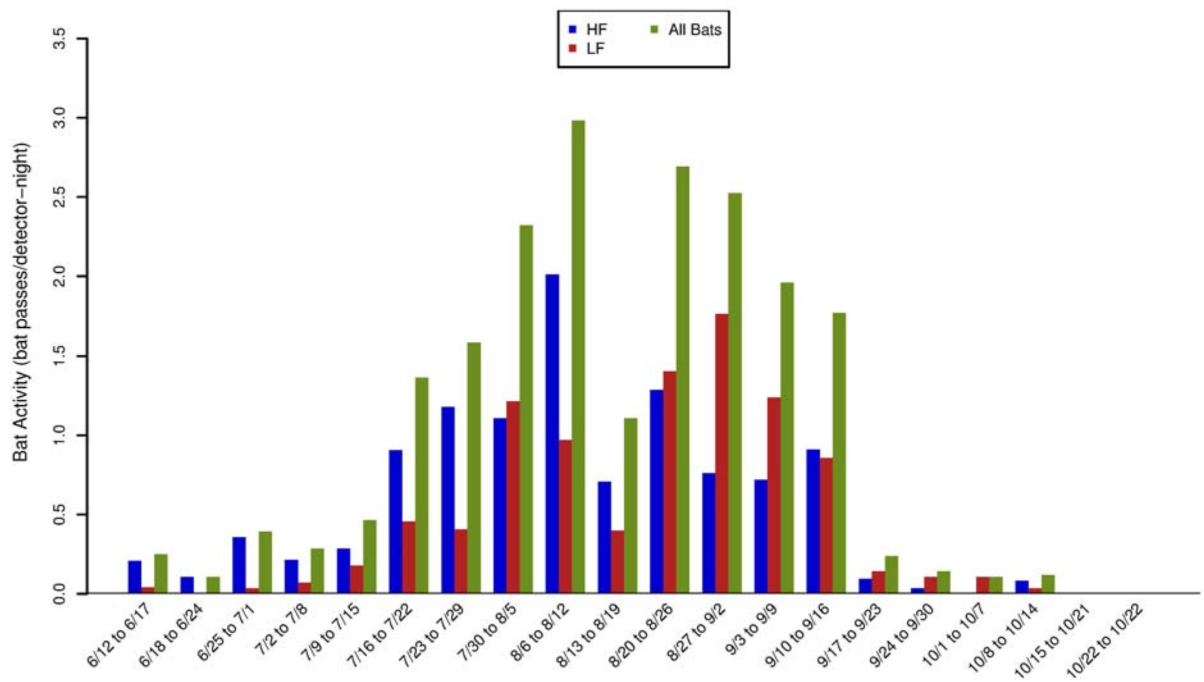

Figure 8. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Sunflower Wind Project for the study period June 12 to October 23, 2013.

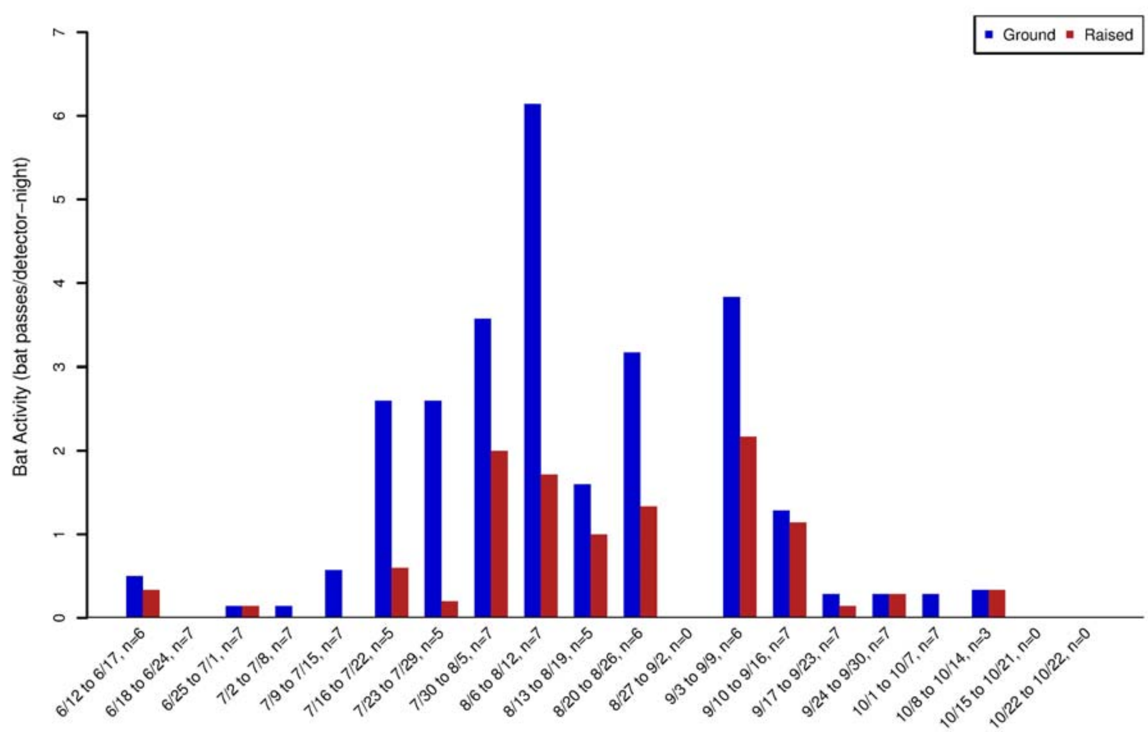

Figure 9. Weekly patterns of bat activity from June 12 to October 23, 2013, at ground and raised met tower stations at the Sunflower Wind Project.

DISCUSSION

Potential Bat Impacts

Assessing the potential impacts of wind energy development on bats at the SWP is complicated because the causes of bat fatalities at turbines are poorly understood (Kunz et al. 2007a, 2007b; Baerwald et al. 2008; Cryan and Barclay 2009; Long et al. 2010a, 2010b) and monitoring elusive, night-flying animals is inherently difficult (O'Shea et al. 2003). Although installed capacity for wind energy has increased rapidly in recent years, release of study results from these existing wind energy facilities has lagged the influx of newly proposed facilities (Kunz et al. 2007b); therefore, it is often the case that information gleaned from existing wind energy facilities is not available to inform assessments at proposed facilities. To date, post-construction monitoring studies of wind energy facilities suggest that:

1) Bat fatality rates show a rough positive correlation with bat activity (Kunz et al. 2007b);

2) The majority of fatalities occur during the post-breeding or fall migration season (August and September; Johnson 2005, Arnett et al. 2008);

3) Migratory tree-roosting species (e.g., eastern red, hoary, and silver-haired bats) compose approximately 75% of reported bats killed (Arnett et al. 2008, Gruver et al. 2009), and;

4) The level of bat fatalities may depend on many variables, including local environmental characteristics and/or specific weather conditions, but no single predictive factor has yet been identified.

Overall Bat Activity

Among publicly-available studies of bat activity at wind energy facilities, most data were collected only during the fall using AnaBat detectors placed near the ground in vegetation cover typical of turbine placement, rather than near features attractive to bats. Therefore, to generate a standardized metric of activity for comparison, this report relies on mean bat activity for the ground detectors during the fall migration period (FMP) to compare activity at the SWP to other studies with similarly-collected data (Figure 10, Appendix A).

While inconsistencies among studies (e.g., differences in study period length and timing, type of equipment, placement of equipment, and presentation of data; Appendix A) complicate comparisons across studies, some generalizations can be made. Considering only the detectors near ground-level at the met towers, bat activity recorded within the SWP during the standardized FMP (1.70 bat passes per detector-night) was the lowest estimate out of all the facilities in Midwest and the third lowest out of all the facilities in North America with similarly-collected data (Appendix A). However, this includes estimates from facilities in different regions, with different habitats and different bat species.

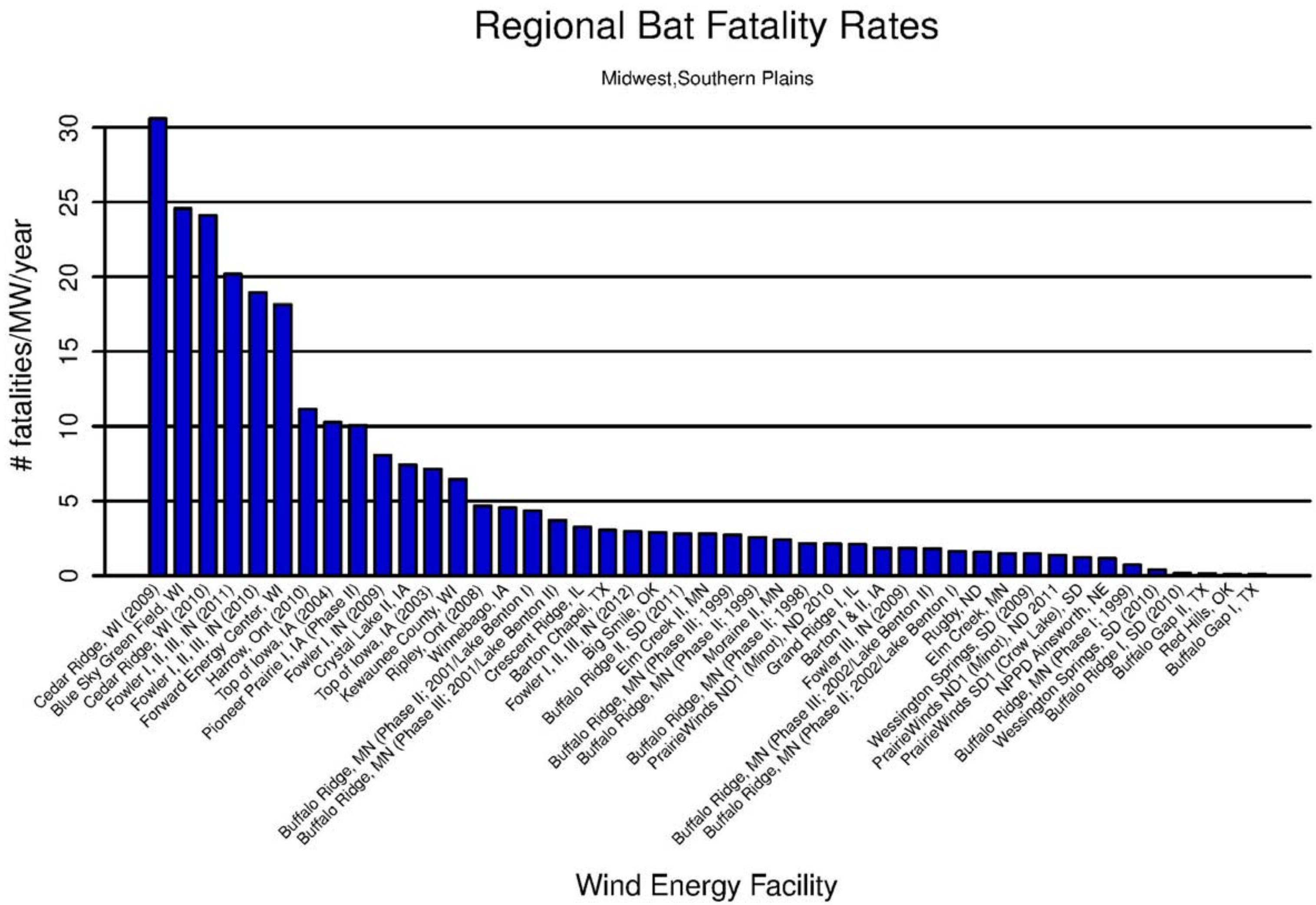

Figure 10. Fatality rates for bats (number of bats per megawatt per year) from publicly-available studies at wind energy facilities in the Midwest and Southern Plains of North America.

Figure 10 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from publicly-available studies at wind energy facilities in the Midwest and Southern Plains of North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Cedar Ridge, WI (09)	BHE Environmental 2010	Buffalo Ridge, MN (Ph. II; 01/Lake Benton I)	Johnson et al. 2004	Fowler III, IN (09)	Good et al. 2011
Blue Sky Green Field, WI	Gruver et al. 2009	Buffalo Ridge, MN (Ph. III; 01/Lake Benton II)	Johnson et al. 2004	Buffalo Ridge, MN (Ph. III; 02/Lake Benton II)	Johnson et al. 2004
Cedar Ridge, WI (10)	BHE Environmental 2011	Crescent Ridge, IL	Kerlinger et al. 2007	Buffalo Ridge, MN (Ph. II; 02/Lake Benton I)	Johnson et al. 2004
Fowler I, II, III, IN (11)	Good et al. 2012	Barton Chapel, TX	WEST 2011	Rugby, ND	Derby et al. 2011b
Fowler I, II, III, IN (10)	Good et al. 2011	Fowler I, II, III, IN (12)	Good et al. 2013	Elm Creek, MN	Derby et al. 2010c
Forward Energy Center, WI	Grodsky and Drake 2011	Big Smile, OK	Derby et al. 2013a	Wessington Springs, SD (09)	Derby et al. 2010f
Harrow, Ont. (10)	NRSI 2011	Buffalo Ridge II, SD (11)	Derby et al. 2012a	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Top of Iowa, IA (04)	Jain 2005	Elm Creek II, MN	Derby et al. 2012b	PrairieWinds SD1 (Crow Lake), SD	Derby et al. 2012d
Pioneer Prairie, IA (Ph. II)	Chodachek et al. 2012	Buffalo Ridge, MN (Ph. III; 99)	Johnson et al. 2000	NPPD Ainsworth, NE	Derby et al. 2007
Fowler I, IN (09)	Good et al. 2011	Buffalo Ridge, MN (Ph. II; 99)	Johnson et al. 2000	Buffalo Ridge, MN (Ph. I; 99)	Johnson et al. 2000
Crystal Lake II, IA	Derby et al. 2010a	Moraine II, MN	Derby et al. 2010d	Wessington Springs, SD (10)	Derby et al. 2011d
Top of Iowa, IA (03)	Jain 2005	Buffalo Ridge, MN (Ph. II; 98)	Johnson et al. 2000	Buffalo Ridge I, SD (10)	Derby et al. 2010b
Kewaunee County, WI	Howe et al. 2002	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c	Buffalo Gap II, TX	Tierney 2009
Ripley, Ont (08)	Jacques Whitford 2009	Grand Ridge I, IL	Derby et al. 2010g	Red Hills, OK	Derby et al. 2013b
Winnebago, IA	Derby et al. 2010e	Barton I & II, IA	Derby et al. 2011a	Buffalo Gap I, TX	Tierney 2007

It is unclear whether monitoring bat activity near ground level accurately represents activity at all heights (Hayes and Gruver 2000). Some research suggests that bat activity in the rotor-swept heights may be more representative of bat exposure to turbines (Baerwald and Barclay 2009). At the SWP, fall bat migration activity recorded by the 45 m detector (1.11 bat passes per detector-night; Table 4) was lower than at the 1 m detectors (1.70 bat passes per night). While bat activity at 45 m (148 ft) detectors might better represent activity in the rotor-swept height (RSH), it is not directly comparable to activity rates reported at other North American studies.

Spatial Variation

Detection rates at the ground detectors varied between met towers; however, the raised unit consistently recorded approximately half the number of bat calls as the corresponding ground detectors. The met towers were located in hay fields and represent potential turbine locations. Because bat activity was generally lower at the raised met tower station than ground level stations, there may a lower potential risk of collision with turbines than if the call rates were similar at both the ground and at the raised station.

Temporal Variation

The highest bat activity occurred within the SWP during the fall, with peak activity in early August (Table 5). Higher activity in early August likely corresponds with the reproductive seasons of bats, when pups are being weaned and foraging rates are high among adult females and newly volant juveniles as well as fall migration. When data collection for this report ended on October 23, 2013, there was a consistent trend of decreasing bat activity from previous weeks, indicating that additional peaks in bat activity after October 23 are unlikely (Figures 8 and 9).

Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality in August and September (the fall migration period) and generally lower mortality earlier in the summer and very low mortality during the spring (Johnson 2005, Arnett et al. 2008). While the survey effort varied among the different studies, a general association between the timing of increased bat call rates and timing of mortality was suggested in the studies that combine AnaBat and fatality surveys, with both call rates and fatalities peaking during the FMP. Based on the available data, it is expected that bat fatalities at the SWP, while likely low overall, will be highest during late summer and early fall at potential turbine locations (i.e., met towers).

Species Composition

Eight of the ten bat species likely to occur in the SWP are known fatalities at wind energy facilities (Table 2). Approximately 54.6% of passes recorded at all met tower stations were by high-frequency bats, suggesting higher relative abundance of species such as eastern red bats and little brown bats as well as other potential species (Table 2). Met tower stations represent potential turbine locations and it is expected that bat species flying at RSH and detected at raised stations are the most vulnerable to collision with turbine blades. In some regions, eastern red bats compose the majority of bat fatalities found during searches (Arnett et al. 2008).

Low-frequency bats (e.g., hoary bat, silver-haired bat, and big brown bat) were the most common frequency group detected at the raised station during the fall and FMP (Table 4). Some LF species, such as hoary bat and silver-haired bat, have been found as fatalities in higher proportions than other species (Arnett et al. 2008). High-frequency species (e.g., eastern red bats and most *Myotis* species) were detected at the raised station less frequently (16.8% of calls; Table 3). Some HF bat carcasses (e.g., little brown bat) have been found in relatively high proportions during fatality monitoring studies (e.g., Kerns and Kerlinger 2004, Jain 2005, Brown and Hamilton 2006b, Gruver et al. 2009). However, *Myotis* species are typically less commonly recorded in the RSH or as fatalities at post-construction studies at wind energy facilities than other species, such as hoary and eastern red bats (Kunz et al. 2007b, Arnett et al. 2008).

Potential Bat Fatality Rates

Bat fatality rates from studies at wind energy facilities across North America have ranged from 0.08 (Chatfield et al. 2012) to 39.70 bat fatalities/MW/year (Fiedler et al. 2007; Appendix A). In general, fatality rates exhibit a high degree of variation for most regions. Thus far, bat fatality rates at wind energy facilities located in agricultural regions of the Dakotas, Illinois, Indiana, Iowa, Minnesota, Wisconsin, and Ontario have ranged from 0.16 to 30.61 bats/MW/year (Appendix A). The reports of moderate to high levels of bat fatalities in agricultural settings in Iowa (Jain 2005, Chodachek et al. 2012); Ontario, Canada (Natural Resource Solutions, Inc. [NRSI] 2011); and Wisconsin (Gruver et al. 2009; BHE Environmental 2010, 2011) suggest that the lack of forested areas does not guarantee low bat fatality rates at wind energy facilities.

Bat activity recorded at the SWP by ground detectors at met towers during the FMP (1.70 ± 0.20 bat passes per detector-night) was the lowest activity when compared to all publicly-available reports from facilities in Midwest and the third lowest when compared to all facilities in North America with similarly-collected activity data (Appendix A), potentially indicating low direct impacts to bats. However, the efficacy of using pre-construction bat activity surveys to predict post-construction fatality rates is unclear. This may be due to a lack of consistent methodologies between projects. Some bat species may also be attracted to turbines out of curiosity, or for mating, foraging, or roosting opportunities (Cryan and Barclay 2009). These two factors further complicate the interpretation of existing data. The pre-construction bat studies completed at the SWP will add to the growing body of research regarding the impacts of wind energy development on bats and will provide a valuable comparison to post-construction studies to be completed at the SWP.

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Appendix A. North American Fatality Summary Tables

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Sunflower, ND	**1.70**				
	Midwest				
Cedar Ridge, WI (2009)	9.97[C,D,E,F]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI	7.7[F]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[C,D,E,F]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)			20.19	355	600
Fowler I, II, III, IN (2010)			18.96	355	600
Forward Energy Center, WI	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)			11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II)			10.06	62	102.3
Fowler I, IN (2009)			8.09	162	301
Crystal Lake II, IA			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI			6.45	31	20.46
Ripley, Ont (2008)			4.67	38	76
Winnebago, IA			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[D]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[D]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL			3.27	33	49.5
Fowler I, II, III, IN (2012)			2.96	355	600
Elm Creek II, MN			2.81	62	148.8
Buffalo Ridge II, SD (2011)			2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
PrairieWinds ND1 (Minot), ND 2010			2.13	80	115.5
Grand Ridge I, IL			2.10	66	99
Barton I & II, IA			1.85	80	160
Fowler III, IN (2009)			1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[D]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[D]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND			1.6	71	149
Elm Creek, MN			1.49	67	100
Wessington Springs, SD (2009)			1.48	34	51
PrairieWinds ND1 (Minot), ND 2011			1.39	80	115.5
PrairieWinds SD1 (Crow Lake), SD			1.23	108	162
NPPD Ainsworth, NE			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Wessington Springs, SD (2010)			0.41	34	51
Buffalo Ridge I, SD (2010)			0.16	24	50.4

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Southern Plains					
Barton Chapel, TX			3.06	60	120
Big Smile, OK			2.90	66	132
Buffalo Gap II, TX			0.14	155	233
Red Hills, OK			0.11	82	123
Buffalo Gap I, TX			0.10	67	134
Northeast					
Mountaineer, WV (2003)			31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY			16.30	84	126
Criterion, MD (2011)			15.61	28	70
Mount Storm, WV (2010)	36.67[G]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)			14.38	51	102
Locust Ridge, PA (Phase II; 2009)			14.11	51	102
Casselman, PA (2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Cohocton/Dutch Hills, NY (2010)			10.32	50	125
Wolfe Island, Ont (July-December 2010)			9.50	86	197.8
Maple Ridge, NY (2007)			9.42	195	321.75
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Casselman, PA (2009)			8.60	23	34.5
Noble Bliss, NY (2008)			7.80	67	100
Criterion, MD (2012)			7.62	28	70
Mount Storm, WV (2011)			7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Maple Ridge, NY (2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.9[C]	8/1/09-09/31/09	4.50	67	100
Casselman Curtailment, PA (2008)			4.40	23	35.4
Noble Altona, NY			4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[C]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1[C]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Wolfe Island, Ont (July-December 2011)			2.49	86	197.8
Noble Chateaugay, NY			2.44	71	106.5
High Sheldon, NY (2010)			2.33	75	112.5
Beech Ridge, WV			2.03	67	100.5
Munnsville, NY (2008)			1.93	23	34.5
High Sheldon, NY (2011)			1.78	75	112.5
Stetson Mountain II, ME (2010)			1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[H]	7/10/09-10/15/09	1.40	38	57
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Kibby, ME (2011)			0.12	44	132
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[E]		31.54	3	1.98

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Rocky Mountains					
Summerview, Alb (2008)	7.65[D]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2006)			10.27	39	70.2
Judith Gap, MT (2006/2007)			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.20	90	135
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[D,E]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[D,E]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ	11.5	5/11/11-10/26/11	1.66	31	65
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009/2010)			2.71	65	150
Nine Canyon, WA			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR			1.98	67	100.5
Big Horn, WA			1.90	133	199.5
Combine Hills, OR (Phase I; 04/05)			1.88	41	41
Linden Ranch, WA			1.68	25	50
Pebble Springs, OR			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR			1.12	38	24.9
Klondike III (Phase I), OR			1.11	125	223.6
Stateline, OR/WA (2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA			0.94	62	136.6
Klondike, OR			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010/2011)			0.57	65	150
Hay Canyon, OR			0.53	48	100.8
Klondike II, OR			0.41	50	75
Windy Flats, WA			0.41	114	262.2
Vantage, WA			0.40	60	90
Wild Horse, WA			0.39	127	229
Goodnoe, WA			0.34	47	94
Marengo II, WA (2009/2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010/2011)			0.22	76	174.8
Marengo I, WA (2009/2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	California				
Shiloh I, CA			3.92	100	150
Shiloh II, CA			2.72	75	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alta Wind I, CA (2011)	4.42[I]	6/26/2009 - 10/31/2009	1.28	100	150
Diablo Winds, CA			0.82	31	20.46
Alite, CA			0.24	8	24
Alta Wind II-V, CA (2011)	0.78	6/26/2009 - 10/31/2009	0.08	190	570

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
D = Activity rate was averaged across phases and/or years
E = Activity rate calculated by WEST from data presented in referenced report
F= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
G = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer, and fall seasons
H = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle
I = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA		Chatfield et al. 2010	Kewaunee County, WI		Howe et al. 2002
Alta Wind I, CA (11)	Solick et al. 2010	Chatfield et al. 2012	Kibby, ME (11)		Stantec 2012
Alta Wind II-V, CA (11)	Solick et al. 2010	Chatfield et al. 2012	Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012
Barton I&II, IA		Derby et al. 2011a	Klondike, OR		Johnson et al. 2003
Barton Chapel, TX		WEST 2011	Klondike II, OR		NWC and WEST 2007
Beech Ridge, WV		Tidhar et al. 2013	Klondike III (Phase I), OR		Gritski et al. 2010
Big Horn, WA		Kronner et al. 2008	Klondike IIIa (Phase II), OR		Gritski et al. 2011
Big Smile, OK		Derby et al. 2013a	Leaning Juniper, OR		Gritski et al. 2008
Biglow Canyon, OR (Ph. I; 08)		Jeffrey et al. 2009a	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Ph. I; 09)		Enk et al. 2010	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Ph. II; 09/10)		Enk et al. 2011a	Linden Ranch, WA		Enz and Bay 2011
Biglow Canyon, OR (Ph. II; 10/ 11)		Enk et al. 2012b	Locust Ridge, PA (Ph. II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Ph. III; 10/ 11)		Enk et al. 2012a	Locust Ridge, PA (Ph. II; 10)		Arnett et al. 2011
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Maple Ridge, NY (06)		Jain et al. 2007
Buffalo Gap I, TX		Tierney 2007	Maple Ridge, NY (07)		Jain et al. 2009a
Buffalo Gap II, TX		Tierney 2009	Maple Ridge, NY (08)		Jain et al. 2009d
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Marengo I, WA (09)		URS Corporation 2010b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Marengo II, WA (09)		URS Corporation 2010c
Buffalo Ridge, MN (Ph. I; 99)		Johnson et al. 2000	Mars Hill, ME (07)		Stantec 2008
Buffalo Ridge, MN (Ph. II; 98)		Johnson et al. 2000	Mars Hill, ME (08)		Stantec 2009a
Buffalo Ridge, MN (Ph. II; 99)		Johnson et al. 2000	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Ph. II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Ph. II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Ph. III; 99)		Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Ph. III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Ph. III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV (2003)		Kerns and Kerlinger 2004
Buffalo Ridge I, SD (10)		Derby et al. 2010b	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge II, SD (11)		Derby et al. 2012a	Nine Canyon, WA		Erickson et al. 2003
Casselman, PA (08)		Arnett et al. 2009a	Noble Altona, NY		Jain et al. 2011b
Casselman, PA (09)		Arnett et al. 2010	Noble Bliss, NY (08)		Jain et al.2009e
Casselman Curtailment, PA (08)		Arnett et al. 2009b	Noble Bliss, NY (09)		Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Chateaugay, NY		Jain et al. 2011c
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Cohocton/Dutch Hill, NY (10)		Stantec 2011	Noble Ellenburg, NY (08)		Jain et al. 2009b
Combine Hills, OR		Young et al. 2006	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Combine Hills, OR (11)		Enz et al. 2012	Noble Wethersfield, NY		Jain et al. 2011a
Crescent Ridge, IL		Kerlinger et al. 2007	NPPD Ainsworth, NE		Derby et al. 2007
Criterion, MD (11)		Young et al. 2012a	Pebble Springs, OR		Gritski and Kronner 2010b
Criterion, MD (12)		Young et al. 2013	Pioneer Prairie, IA (Ph. II)		Chodachek et al. 2012
Crystal Lake II, IA		Derby et al. 2010a	PrairieWinds ND1 (Minot), ND		Derby et al. 2011c
Diablo Winds, CA		WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Dillon, CA		Chatfield et al. 2009	PrairieWinds SD1, SD		Derby et al. 2012d
Dry Lake I, AZ	Thompson et al. 2011	Thompson et al. 2011	Red Hills, OK		Derby et al. 2013b
Dry Lake II, AZ	Thompson and Bay 2012	Thompson and Bay 2012	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (08)		Jeffrey et a. 2009b	Rugby, ND		Derby et al. 2011b
Elkhorn, OR (10)		Enk et al. 2011b	Shiloh I, CA		Kerlinger et al. 2009
Elm Creek, MN		Derby et al. 2010c	Shiloh II, CA		Kerlinger et al. 2010b
Elm Creek II, MN		Derby et al. 2012b	Stateline, OR/WA (02)		Erickson et al. 2004
Foote Creek Rim, WY (Ph. I; 99)		Young et al. 2003a	Stateline, OR/WA (03)		Erickson et al. 2004
Foote Creek Rim, WY (Ph. I;	Gruver 2002	Young et al. 2003a,	Stateline, OR/WA (06)		Erickson et al. 2007

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
00)		2003b			
Foote Creek Rim, WY (Ph. I; 01-02)	Gruver 2002	Young et al. 2003a, 2003b	Stetson Mountain, ME (09)	Stantec 2009c	Stantec 2009c
Forward Energy Center, WI	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler I, IN (09)		Good et al. 2011	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Fowler III, IN (09)		Good et al. 2011	Summerview, Alb (06)		Brown and Hamilton 2006b
Fowler I, II, III, IN (10)		Good et al. 2011	Summerview, Alb (08)	Baerwald 2008	Baerwald 2008
Fowler I, II, III, IN (11)		Good et al. 2012	Top of Iowa, IA (03)		Jain 2005
Fowler I, II, III, IN (12)		Good et al. 2013	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Goodnoe, WA		URS Corporation 2010a	Tuolumne (Windy Point I), WA		Enz and Bay 2010
Grand Ridge, IL		Derby et al. 2010g	Vansycle, OR		Erickson et al. 2000
Harrow, Ont. (10)		NRSI 2011	Vantage, WA		Ventus 2012
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Wessington Springs, SD (09)		Derby et al. 2010f
Hay Canyon, OR		Gritski and Kronner 2010a	Wessington Springs, SD (10)		Derby et al. 2011d
High Sheldon, NY (10)		Tidhar et al. 2012a	White Creek, WA (07-11)		Downes and Gritski 2012b
High Sheldon, NY (11)		Tidhar et al. 2012b	Wild Horse, WA		Erickson et al. 2008
High Winds, CA (04)		Kerlinger et al. 2006	Windy Flats, WA		Enz et al. 2011
High Winds, CA (05)		Kerlinger et al. 2006	Winnebago, IA		Derby et al. 2010e
Hopkins Ridge, WA (06)		Young et al. 2007	Wolfe Island, Ont (Jul-Dec 09)		Stantec Ltd. 2010b
Hopkins Ridge, WA (08)		Young et al. 2009c	Wolfe Island, Ont (Jul-Dec 10)		Stantec Ltd. 2011b
Judith Gap, MT (06-07)		TRC 2008	Wolfe Island, Ont (Jul-Dec 11)		Stantec Ltd. 2012
Judith Gap, MT (09)		Poulton and Erickson 2010			

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011)	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011)	0.08	Desert scrub	Chatfield et al. 2012
Barton I & II, IA	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV	2.03	Forest	Tidhar et al. 2013
Big Horn, WA	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK	2.9	Grassland, agriculture	Derby et al. 2013a
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009/2010)	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010/2011)	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010/2011)	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1999)	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2010)	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011)	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009a
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2010
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2009b

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	Agriculture, forest	Stantec 2011
Combine Hills, OR (Phase I; 04/05)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Crystal Lake II, IA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA	0.82	NA	WEST 2006, 2008
Dillon, CA	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	Shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN	1.49	Agriculture	Derby et al. 2010c
Elm Creek II, MN	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.97	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	1.05	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	Grassland	Young et al. 2003a
Forward Energy Center, WI	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	Agriculture	Good et al. 2011
Fowler III, IN (2009)	1.84	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2010)	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	2.96	Agriculture	Good et al. 2013
Goodnoe, WA	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2004)	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2005)	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006/2007)	8.93	Agriculture/grassland	TRC 2008

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Judith Gap, MT (2009)	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	0.12	Forest; commercial forest	Stantec 2012
Kittitas Valley, WA (2011-2012)	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR	0.77	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	9.42	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2008)	4.96	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009/2010)	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009/2010)	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Moraine II, MN	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Nine Canyon, WA	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Altona, NY	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al.2009e
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE	1.16	Agriculture/grassland	Derby et al. 2007
Pebble Springs, OR	1.55	Grassland	Gritski and Kronner 2010b
Pioneer Prairie I, IA (Phase II)	10.06	Agriculture, grassland	Chodachek et al. 2012

Appendix A2. Fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
PrairieWinds ND1 (Minot), ND 2010	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND 2011	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1 (Crow Lake), SD	1.23	Grassland	Derby et al. 2012d
Red Hills, OK	0.11	Grassland	Derby et al. 2013b
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Rugby, ND	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA	3.92	Agriculture/grassland	Kerlinger et al. 2010a
Shiloh II, CA	2.72	Agriculture	Kerlinger et al. 2010b
Stateline, OR/WA (2002)	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	Forested	Normandeau Associates 2011
Stetson Mountain II, ME (2010)	1.65	Forested	Normandeau Associates 2010
Summerview, Alb (2006)	10.27	Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2008)	11.42	Agriculture/grassland	Baerwald 2008
Top of Iowa, IA (2003)	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR	1.12	Agriculture/grassland	Erickson et al. 2000
Vantage, WA	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	1.48	Grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.41	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA	4.54	Agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Ltd. 2010b
Wolfe Island, Ont (July-December 2010)	9.5	Grassland	Stantec Ltd. 2011b
Wolfe Island, Ont (July-December 2011)	2.49	Grassland	Stantec Ltd. 2012

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Alite, CA	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta Wind I, CA (2011)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta Wind II-V, CA (2011)	190	570	NA	41	120-m radius circle	14.5 months	Every two weeks
Barton Chapel, TX	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Barton I & II, IA	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Beech Ridge, WV	67	100.5	80	67	40 m radius	7 months	Every two days
Big Horn, WA	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK	66	132	NA	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009/2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010/2011)	65	150	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010/2011)	76	174.8	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Blue Sky Green Field, WI	88	145	80	30	160 m x 160 m	Fall, spring	Daily(10 turbines), weekly (20 turbines)
Buena Vista, CA	38	38	45-55	38	75-m radius	1 year	Monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX	67	134	NA	21	215 m x 215 m	10 months	Every 3 weeks
Buffalo Gap II, TX	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994/1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	Varies. See number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	Weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Castle River, Alb (2001)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	Spring, summer, fall	Daily, every 4 days; late fall searched every 3 days

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly
Combine Hills, OR (Phase I; 04/05)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	Daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	Weekly
Crystal Lake II, IA	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	Spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Dry Lake I, AZ	30	63	78	15	160 m x 160 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly
Elm Creek II, MN	62	148.8	80	30	200 x 200m (2 random migration search areas 100 x 100m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont	66	99	80	66	40-m radius	2 years	Weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Forward Energy Center, WI	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	Spring, summer, fall	Weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	Spring, fall	Daily, weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	Turbines (80 m circular plot), roads and pads (out to 80 m)	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	Roads and pads (out to 80 m)	2.5 months	Weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	Weekly, bi-weekly
Goodnoe, WA	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Winds, CA (2004)	90	162	60	90	75-m radius	1 year	Bi-monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
High Winds, CA (2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ	5	7.5	80	5	130 m x 120 m	9 months	Weekly
Judith Gap, MT (2006/2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly
Kewaunee County, WI	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike, OR	16	24	80	16	140 m x 140 m	1 year	Monthly
Klondike II, OR	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Klondike IIIa (Phase II), OR	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Leaning Juniper, OR	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	Daily
Madison, NY	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Marengo I, WA (2009/2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009/2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	Weekly, bi-weekly
Melancthon, Ont (Phase I)	45	NA	NA	45	35m radius	5 months	Weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	Daily (half turbines), weekly (half turbines)
Moraine II, MN	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (2009)	132	264	78	44	Varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	Varied	6 months	Daily
Mount Storm, WV (Fall 2008)	82	164	78	27	Varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	Daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	Spring, summer, fall	Weekly
Nine Canyon, WA	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Weekly, 8 turbines searched daily from July 1 to August 15
Noble Chateaugay, NY	71	106.5	80	24	120 m x 120 m	Spring, summer, fall	Weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY	84	126	80	28	120 m x 120 m	Spring, summer, fall	Weekly
NPPD Ainsworth, NE	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK	68	102	70	68	20m radius	3 months (2 years)	Bi-monthly
Pebble Springs, OR	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA	90	135	65	40	NA	1 year	Bi-weekly
Pioneer Prairie I, IA (Phase II)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	Weekly (spring and fall), every two weeks (summer), monthly (winter)
PrairieWinds ND1 (Minot), ND 2010	80	115.5	89	35	Minimum of 100 m x 100 m	3 seasons	Bi-monthly
PrairieWinds ND1 (Minot), ND 2011	80	115.5	80	35	Minimum 100 x 100m	3 season	Twice monthly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
PrairieWinds SD1 (Crow Lake), SD	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	Daily, weekly
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	Daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45m radius	6.5 months	Daily, 3x/week, 2x/week
Red Canyon, TX	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK	82	123	NA	20 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (Fall 2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rugby, ND	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (2007)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Shiloh I, CA	100	150	65	100	105-m radius	3 years	Weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Shiloh II, CA	75	150	33 turbs = 115; 42 turbs = 125	25	100m radius	1 yr	Once/week
SMUD Solano, CA	22	15	65	22	60-m radius	1 year	Bi-monthly
Stateline, OR/WA (2002)	454	299	50	124	Minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	Minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	Variable turbine strings	1 year	Bi-weekly
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly
Stetson Mountain I, ME (2011)	38	57	80	19	Varied	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	Varied	6 months	Weekly (3 turbines twice a week)
Summerview, Alb (2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2008)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Tuolumne (Windy Point I), WA	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA	127	229	67	64	110 m from two turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA	114	262.2	NA	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA	10	20	78	10	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	Spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	Summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly

Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of turbines	Total MW	Tower size (m)	Number turbines searched	Plot Size	Length of Study	Survey Frequency
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA	Chatfield et al. 2010	Klondike II, OR	NWC and WEST 2007
Alta Wind I, CA (11)	Chatfield et al. 2012	Klondike III (Phase I), OR	Gritski et al. 2010
Alta Wind II-V, CA (11)	Chatfield et al. 2012	Klondike IIIa (Phase II), OR	Gritski et al. 2011
Barton I & II, IA	Derby et al. 2011a	Leaning Juniper, OR	Gritski et al. 2008
Barton Chapel, TX	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV	Tidhar et al. 2013	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA	Kronner et al. 2008	Linden Ranch, WA	Enz and Bay 2011
Big Smile, OK	Derby et al. 2013a	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Madison, NY	Kerlinger 2002b
Biglow Canyon, OR (Phase II; 09/10)	Enk et al. 2011a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase II; 10/11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase III; 10/11)	Enk et al. 2012a	Maple Ridge, NY (08)	Jain et al. 2009d
Blue Sky Green Field, WI	Gruver et al. 2009	Marengo I, WA (09)	URS Corporation 2010b
Buena Vista, CA	Insignia Environmental 2009	Marengo II, WA (09)	URS Corporation 2010c
Buffalo Gap I, TX	Tierney 2007	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap II, TX	Tierney 2009	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Melancthon, Ont (Phase I)	Stantec Ltd. 2008
Buffalo Ridge, MN (94/95)	Osborn et al. 1996, 2000	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Moraine II, MN	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II;98)	Johnson et al. 2000	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Nine Canyon, WA	Erickson et al. 2003
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge I, SD (10)	Derby et al. 2010b	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge II, SD (11)	Derby et al. 2012a	Noble Chateaugay, NY	Jain et al. 2011c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman Curtailment, PA (08)	Arnett et al. 2009b	Noble Ellenburg, NY (08)	Jain et al. 2009b
Castle River, Alb (01)	Brown and Hamilton 2006a	Noble Ellenburg, NY (09)	Jain et al. 2010c
Castle River, Alb (02)	Brown and Hamilton 2006a	Noble Wethersfield, NY	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011	Pine Tree, CA	BioResource Consultants 2010
Combine Hills, OR	Young et al. 2006	Pioneer Prairie I, IA (Phase II)	Chodachek et al. 2012
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND	Derby et al. 2011c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Crescent Ridge, IL	Kerlinger et al. 2007	PrairieWinds SD1, SD	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Crystal Lake II, IA	Derby et al. 2010a	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
Diablo Winds, CA	WEST 2006, 2008	Red Canyon, TX	Miller 2008
Dillon, CA	Chatfield et al. 2009	Red Hills, OK	Derby et al. 2013b
Dry Lake I, AZ	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ	Thompson and Bay 2012	Ripley, Ont (Fall 09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rugby, ND	Derby et al. 2011b
Elkhorn, OR (10)	Enk et al. 2011b	San Gorgonio, CA	Anderson et al. 2005
Elm Creek, MN	Derby et al. 2010c	Searsburg, VT (07)	Kerlinger 2002a
Elm Creek II, MN	Derby et al. 2012b	Shiloh I, CA	Kerlinger et al. 2009
Erie Shores, Ont	James 2008	Shiloh II, CA	Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	SMUD Solano, CA	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Stateline, OR/WA (02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a	Stateline, OR/WA (03)	Erickson et al. 2004
Forward Energy Center, WI	Grodsky and Drake 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, IN (09)	Good et al. 2011	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, II, III, IN (10)	Good et al. 2011	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, II, III, IN (11)	Good et al. 2012	Stetson Mountain II, ME (10)	Normandeau Associates 2010

Appendix A3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Fowler I, II, III, IN (12)	Good et al. 2013	Summerview, Alb (06)	Brown and Hamilton 2006b
Fowler III, IN (09)	Good et al. 2011	Summerview, Alb (08)	Baerwald 2008
Goodnoe, WA	URS Corporation 2010a	Tehachapi, CA	Anderson et al. 2004
Grand Ridge I, IL	Derby et al. 2010g	Top of Iowa, IA (03)	Jain 2005
Harrow, Ont (10)	Natural Resource Solutions 2011	Top of Iowa, IA (04)	Jain 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Tuolumne (Windy Point I), WA	Enz and Bay 2010
Hay Canyon, OR	Gritski and Kronner 2010a	Vansycle, OR	Erickson et al. 2000
High Sheldon, NY (10)	Tidhar et al. 2012a	Vantage, WA	Ventus Environmental Solutions 2012
High Sheldon, NY (11)	Tidhar et al. 2012b	Wessington Springs, SD (09)	Derby et al. 2010f
High Winds, CA (04)	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2011d
High Winds, CA (05)	Kerlinger et al. 2006	White Creek, WA (07-11)	Downes and Gritski 2012b
Hopkins Ridge, WA (06)	Young et al. 2007	Wild Horse, WA	Erickson et al. 2008
Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA	Enz et al. 2011
Jersey Atlantic, NJ	NJAS 2008a, 2008b, 2009	Winnebago, IA	Derby et al. 2010e
Judith Gap, MT (06-07)	TRC 2008	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Judith Gap, MT (09)	Poulton and Erickson 2010	Wolfe Island, Ont (July-Dec 09)	Stantec Ltd. 2010b
Kewaunee County, WI	Howe et al. 2002	Wolfe Island, Ont (Jan-June 10)	Stantec Ltd. 2011a
Kibby, ME (11)	Stantec 2012	Wolfe Island, Ont (July-Dec 10)	Stantec Ltd. 2011b
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (Jan-June 11)	Stantec Ltd. 2011c
Klondike, OR	Johnson et al. 2003	Wolfe Island, Ont (July-Dec 11)	Stantec Ltd. 2012

Whooping Crane Habitat Review
Sunflower Wind Project
Morton and Stark Counties, North Dakota

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November 20, 2013

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Sunflower Wind Project (SFWP) is proposed for development by Sunflower Wind Project LLC (Sunflower), a wholly owned subsidiary of Infinity Wind Power (Infinity), in Morton and Stark Counties, North Dakota. Sunflower requested that Western EcoSystems Technology, Inc. (WEST) implement a desktop review and analysis of potential whooping crane habitat resources within the SFWP and to compare these resources to areas outside of the project boundary to the north, south, east, and west. The habitat review and analysis evaluates whether or not the proposed SFWP area represents high, average, or low potential whooping crane habitat as compared to alternate locations. From this analysis all parties can then discuss what impacts there may be to whooping cranes from development of the SFWP.

PROJECT AREA

The SFWP is located in Morton and Stark Counties, North Dakota, approximately three miles (mi; 4.8 kilometers [km]) south of the town of Hebron (Figure 1). The SFWP, currently about 21,947 acres (ac; 89 square kilometers [km2]; 34 square miles [mi2]) is located in west-central North Dakota and more specifically western Morton and eastern Stark Counties. The landscape within the SFWP is generally flat with more rolling lands in the northern third of the project area. Elevation ranges from 679 meters (m; 2,228 feet [ft]) to 817 m (2,679 ft). Historically, the SFWP's landscape was dominated by grasslands but has since been converted largely to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found around farmsteads, within planted shelter belts, and along/within drainages. Wetlands are scattered throughout the SFWP with many being man-made.

Cultivated cropland and herbaceous/pasture/hay lands are approximately equal in amount and comprise almost 95% of the study area. Of the remaining 5%, 3.5% is developed while wetlands, forest, and barren lands, in that order, make up the rest of the landscape (Fry et al. 2011; Figure 2). Common agricultural crops include small grains, corn, sunflowers, and alfalfa.

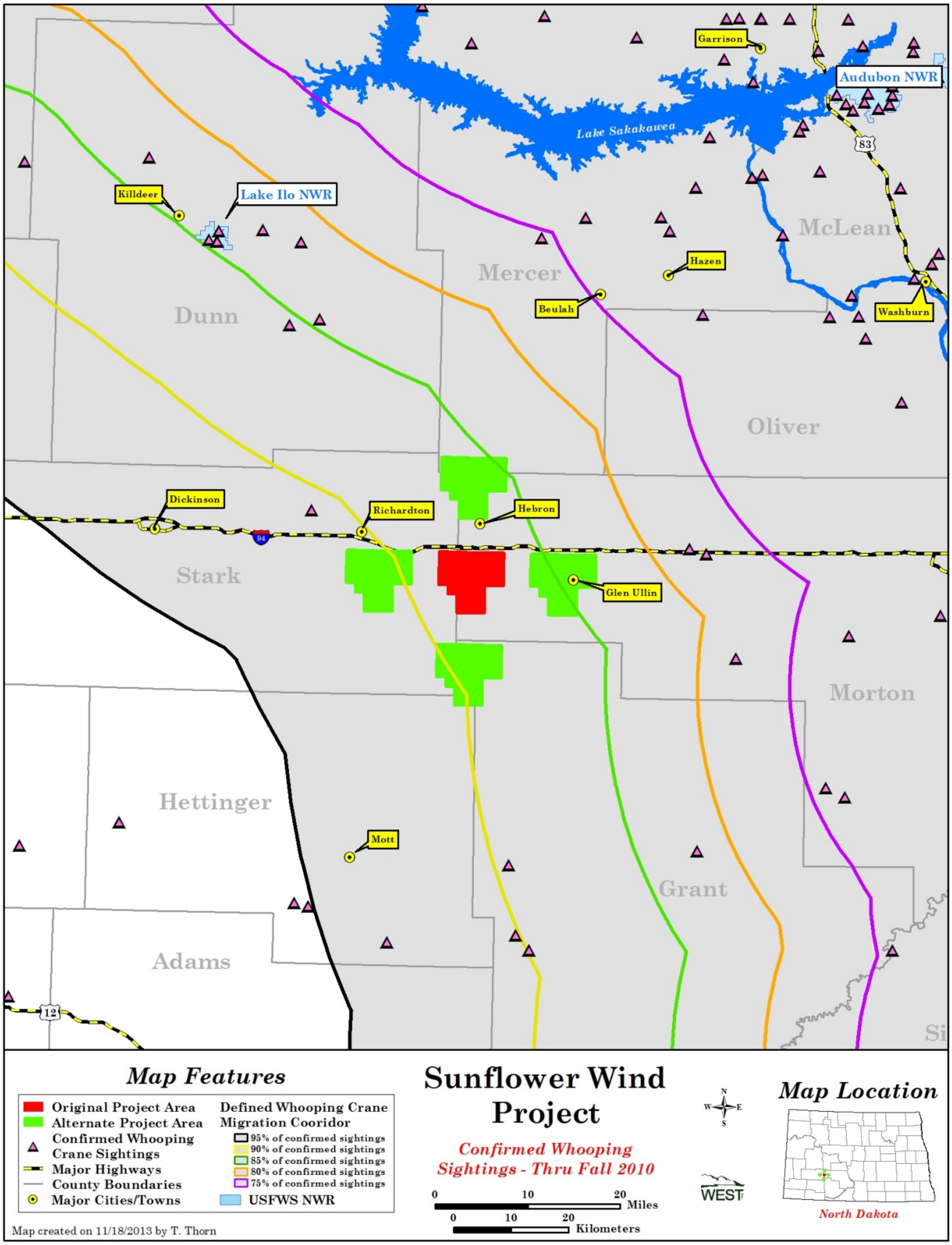

Figure 1. Location of the Sunflower Wind Project, alternate areas, and whooping crane observations.

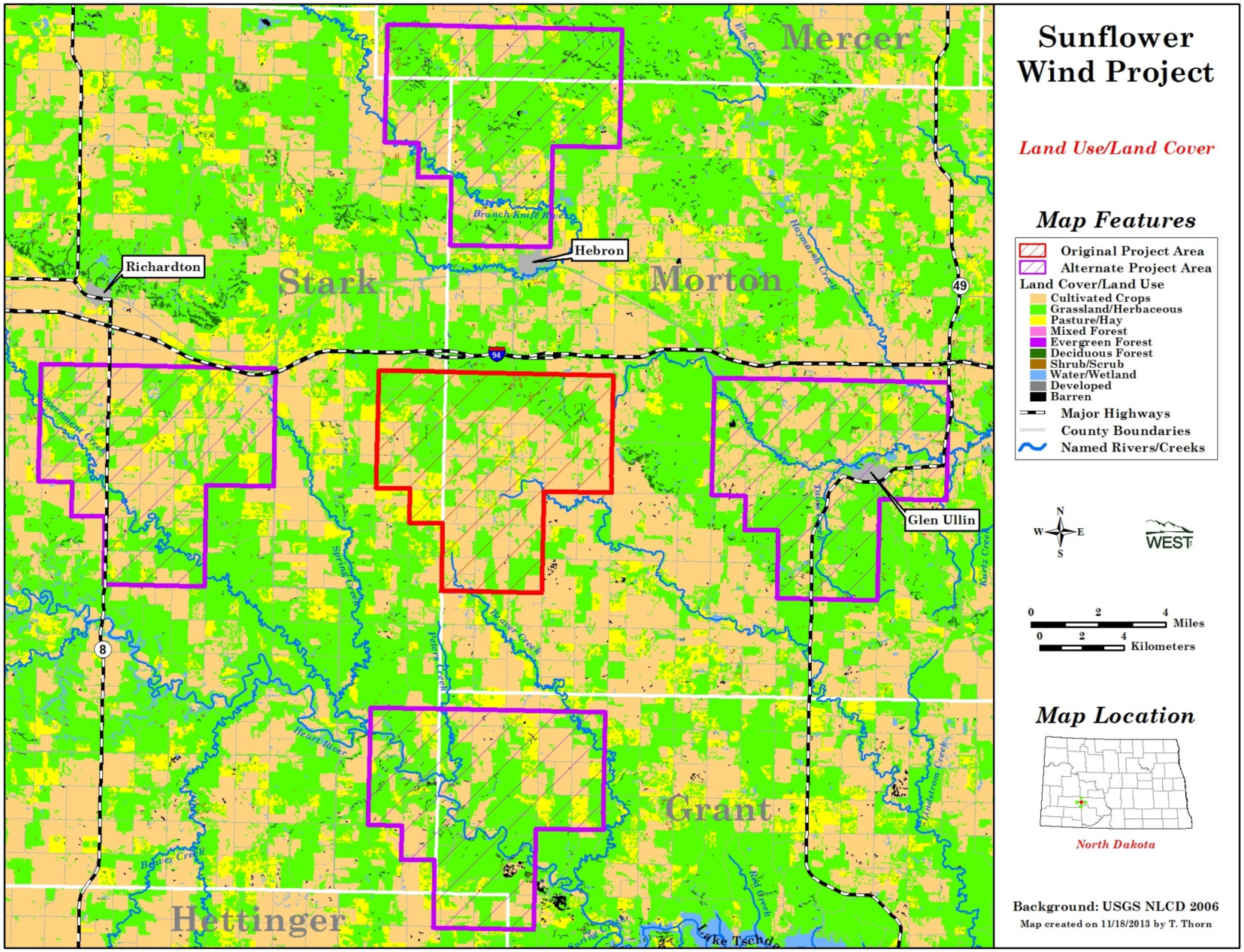

Figure 2. Land Use/Land Cover within and around the Sunflower Wind Project.

METHODS

A desktop review was completed using ArcGIS, ArcMap 10.1, land cover information from the National Land Cover Database (NLCD 2006), wetland data from the National Wetland Inventory (NWI), 2012 NAIP aerial imagery, and the current project boundary as provided by Sunflower. A site visit was not completed by WEST for this exercise specifically, but WEST has conducted other surveys at the SFWP and confirmed that the mapping generally agrees with current conditions.

The potential whooping crane habitat analysis included a comparison of land cover within the proposed SFWP boundary and four alternate areas of the same dimensions located adjacent (based on the SFWP's boundary extent) to the SFWP boundary in the four cardinal directions (see Figures 1, 2, and 3). A recently developed potentially suitable habitat assessment (Watershed Institute 2012) was also used to quantify and compare whooping crane habitat within the study areas. This assessment first screens all wetlands within the study areas for minimum size, visual obstructions, and disturbances. Those wetlands left are then quantified by their size, density of wetlands around them, distance to food, whether they are natural or man-made, and their water regime as a means to quantify suitability. This work was initially done in Kansas and the results were compared to Quivira National Wildlife Refuge, a traditional migratory stopover area. In Kansas, it was determined that a score of 12 or higher represented potentially suitable whooping crane habitat.

RESULTS

There are 10,494 ac of cropland within the proposed project area, or 47.7% of the total area. Grass and herbaceous lands make up approximately 40.8% of the project area while pasture/hay and developed lands occupy another 6.3% and 3.5% respectively. Water, forest, shrub/scrub, and barren habitats comprise the remaining 1.7% of the SFWP (Table 1).

Croplands, Grasslands, and Other Habitats

The percentage of cropland varied between the project area and comparison areas, with the SFWP containing the most (47.7%) and the north comparison area the least (25.2%; Table 1). The other three reference areas had cropland percentages ranging between 31.4% and 43.9% (Table 1). All cropland has the potential as foraging areas for whooping cranes but crop type could influence the extent of use of a particular field during any one migration season.

Percentages of grassland/herbaceous habitat also varied between analyzed areas with the north (62.1%) reference area having the most and the SFWP and west area the least (40.8% and 38.2% respectively; Table 1). The east and south reference areas had grassland/herbaceous percentages approximately in the middle of the high and low percentages calculated (Table 1). The influence of grassland habitats on migrating whooping crane behavior is unknown; however, short grasslands (i.e. grazed pasture) adjacent to wetlands may provide loafing areas and cranes may utilize grasslands to some degree for foraging.

All other habitat types comprised approximately 11.5% of the SFWP's area. This is at the low end of the range (11.3% - 17.9%) of other habitats occurring within the alternate areas (Table 1). Pasture/hay and developed lands made up the bulk of the remaining habitats in all areas (Table 1).

Table 1. Land Use/Land Cover within the Sunflower Wind Project and adjacent areas.

	SFWP		North		East		South		West	
Habitat Type	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Cultivated Crops	10,493.8	47.7	5,540.7	25.2	8,407.4	38.3	6,902.7	31.4	9,648.4	43.9
Grassland/Herbaceous	8,965.4	40.8	13,646.3	62.1	11,032.6	50.2	11,755.9	53.5	8,406.0	38.2
Pasture/Hay	1,394.8	6.3	1,460.6	6.6	566.6	2.6	1,818.2	8.3	2,701.6	12.3
Developed	761.9	3.5	374.9	1.7	1,144.6	5.2	753.5	3.4	901.8	4.1
Water/Wetlands	188.0	0.9	308.0	1.4	454.7	2.1	343.8	1.6	248.4	1.1
Forests	108.4	0.5	541.2	2.5	197.8	0.9	267.9	1.2	57.6	0.3
Shrub/Scrub	62.8	0.3	91.2	0.4	105.7	0.5	34.1	0.2	18.5	0.1
Barren	8.2	<0.1	20.5	0.1	6.5	<0.1	9.1	<0.1	4.5	<0.1

National Land Cover Database 2006; Fry et al. 2011.

Wetlands

NWI wetland data was used for this analysis because it represents wetland features to a higher degree than the NLCD. For this analysis, it is assumed that all wetlands are potential whooping crane roosting areas under one water regime or another (e.g., drought, normal, or flood). The SFWP had the second lowest number, total acres, mean size, and size range of wetland basins compared to the reference areas (Table 2). The west reference area had the highest number of basins (194), total acres (393.6 ac) and largest size range (<0.1 to 200 ac). Wetland basins within the west area also had the second highest mean size (Table 2). The south reference area had the fewest number of wetland basins (61) but largest wetland mean size (4.1 ac; Table 2). These numbers are somewhat misleading due to the presence of the Heart River bisecting this reference area (Figure 3). The Heart River was one basin accounting for approximately 175 of the 250 total wetland acres within the area. The northern study area had the second highest number of wetland basins (164) but the lowest total wetland acres, smallest mean wetland size (0.6), and narrowest wetland size range (<0.1 to 5.0; Table 2). For the east reference area, the numbers for the four wetland statics were in the middle compared to the other reference areas and the SFWP (Table 2).

Freshwater emergent (52.8%) and freshwater ponds (44.4%) made up the highest percentages of wetland types in the SFWP, with freshwater forested/shrub and other wetlands making up the remaining approximately 2.8% of wetlands (Table 3). The north reference area had similar wetland types and percentages as the SFWP with a small amount of riverine and other wetlands (Table 3). Almost 70% of the south alternate area was comprised of riverine wetlands due to the presence of the Heart River. The bulk of the wetland types composing the east reference area were freshwater ponds (45.9%) and lakes (39.6%) while freshwater emergent wetlands dominated (93.2%) the type of wetlands in the western study area (Table 3). See Figure 3 for distribution of wetland types within the analyzed areas.

To summarize, the SFWP had the second lowest number, total acres, mean size, and size range of wetland basins compared to the reference areas and was dominated by freshwater emergent wetlands and ponds. The west alternate area had the highest number, total acres, and widest size range of wetlands of all the areas with the bulk of the wetlands being freshwater emergent. The north reference area had a relatively high number of freshwater emergent wetlands and freshwater ponds but they were small in size. The south study area contained the fewest wetland basins but these wetlands had the highest mean size. The Heart River, represented by a single riverine basin, comprised approximately 70% of the total wetland acres of this area. Wetland statistics for the east alternate area were basically in the middle of range for all study areas. This area was the only one to contain any NWI lake habitat.

Table 2. Comparison of the number of wetland basins and mean size within the Sunflower Wind Project and adjacent areas.

Area	Basins	Total - acres	Mean Size - acres	Range - acres
SFWP	126	110.3	0.9	0.1 – 28.4
North	164	106.3	0.6	<0.1 – 5.0
South	61	250.0	4.1	0.1 – 174.6
East	139	206.7	1.5	0.1 – 38.9
West	194	393.6	2.0	<0.1 – 200.0

Data Source: NWI data with wetland parts dissolved.

Table 3. Wetland types within the Sunflower Wind Project and adjacent areas.

	SFWP		North		East		South		West	
Wetland Type	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Freshwater Emergent	58.2	52.8	43.5	41.0	28.7	13.9	48.2	19.3	366.7	93.2
Freshwater Forested/Shrub	0.9	0.8			0.5	0.2	10.0	4.0	4.0	1.0
Freshwater Pond	48.9	44.4	61.4	57.8	94.9	45.9	18.6	7.4	22.2	5.6
Riverine			0.2	0.2			173.1	69.3		
Lake					81.8	39.6				
Other	2.3	2.1	1.1	1.0	0.7	0.3	0.1	<0.1	0.4	0.1

Data Source: NWI 2010.

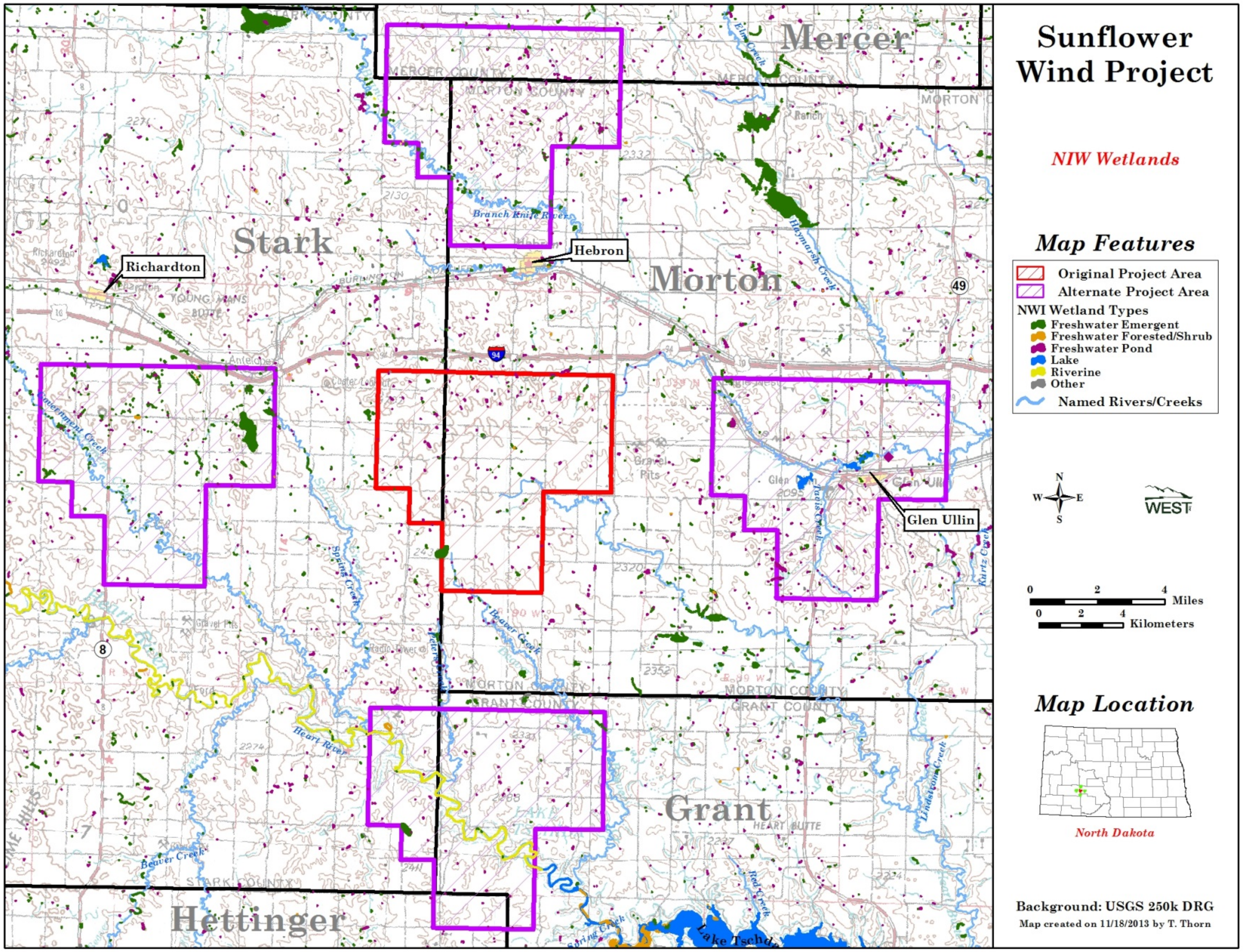

Figure 3. NWI wetlands within and around the Sunflower Wind Project.

Whooping Crane Suitable Habitat Assessment

The habitat assessment model identified 74 wetland basins within the SFWP as potentially suitable whooping crane roosting habitat. The mean suitability score for these wetlands was 8.5 with the scores ranging from four to 13 (Table 4). This mean suitability score and range was similar to the score and range for the four reference areas. The west reference area had the highest (9.0) mean suitability score (Table 4). The overall rankings are generally below what was determined as suitable potential habitat in Kansas (a mean score of 12 or more; Watershed Institute 2012).

Table 4. Comparison of suitable whooping crane habitat within the Sunflower Wind Project and adjacent areas.

Area	Basins	Total - acres	Mean Score	Score range
SFWP	74	91.7	8.5	4 – 13
North	68	66.9	8.2	5 – 11
South	34	39.8	8.1	6 – 13
East	54	102.9	8.6	6 – 14
West	54	274.8	9.0	7 – 14

Data Derived From: Potentially Suitable Habitat Assessment, Watershed Institute 2012.

Whooping Crane Migration Corridor and Confirmed Sightings

The SFWP and all four review areas are located inside the defined (95% of confirmed sightings) whooping crane migration corridor and no whooping cranes have been documented within these areas (CWCTP 2009; Figure 1). The closest confirmed sighting (through fall 2010) to the SFWP is approximately 15 mi (24.1 km) northwest of the boundary (Figure 1). This same sighting is approximately 6 mi (9.7 km) from the west alternative's boundary (Figure 1). It should be noted that reported whooping crane observations are mostly random events by the public or focused around refuges and other areas of management interest and not the result of a systematic search. Therefore, just because an area has no documented whooping crane sightings, does not mean that birds do not use the area.

DISCUSSION

Whooping cranes are currently listed as endangered under the Endangered Species Act (32 FR 4001, 1967 March 11) except where nonessential experimental populations exist (66 FR 33903-33917, 2001 June 26; 62 FR 38932-38939, 1997 July 21; and 58 FR 5647-5658, 1993 January 22). In the US, the whooping crane was listed as threatened with extinction in 1967 and endangered in 1970 – both listings were "grandfathered" into the Endangered Species Act of 1973 (ESA 1973). The 2012 – 2013 winter population within the primary wintering grounds was estimated at 257 birds (178 – 362, 95% confidence interval.). There was another 22 whooping cranes thought to be outside of the primary wintering grounds when systematic surveys were conducted (USFWW 2013). Whooping cranes typically migrate from their breeding grounds in Wood Buffalo National Park, Canada to their wintering areas in Aransas National Wildlife Refuge, Texas. During the migration, most birds pass through central North Dakota.

The US Fish and Wildlife Service (USFWS) defined a migration corridor for whooping cranes based on the historical sightings of whooping cranes from the early 1960's through 2009 (CWCTP 2009). This corridor encompasses approximately 95% of the observations and is sub-divided into 5% increments starting at 75%. The SFWP is within the area encompassing 85% to 90% of confirmed whooping crane sightings and is approximately 71 mi (114.2 km) west of the migration corridor centerline (CWCTP 2009; Figure 1). The USFWS has expressed concern with wind and other above ground developments (e.g., transmission lines) that are built anywhere within the defined corridor, but with more emphasis placed on those projects within the region that encompasses 75% of the observations.

Confirmed whooping sightings to the north and south of the project indicates the potential for whooping cranes to fly through the area during migration. Whooping cranes generally migrate at 305-1830 m (1,000-6,000 ft) altitude, well above turbine height (Stehn 2007), and thus for the most part are unlikely to collide with turbines. However, as whooping cranes ascend and descend during takeoff and landing, or migrate during inclement weather, they may fly at lower altitudes and may fly at altitudes corresponding to the rotor-swept areas. In summary, low altitude flight is generally of short duration in the morning and evenings with more time and distance covered at higher elevation during typical migration flight; reducing potential risk to whooping cranes.

No whooping cranes have been reported as being killed or injured by wind turbines (NWCC 2004), but one sandhill crane (*Grus canadensis*) was reported at the Altamont wind energy facility in California (Smallwood and Karas 2009), it is unclear if this was a result of turbine collision or collision with a power line. Two sandhill cranes were also apparently struck by turbines during a recent study of wintering cranes in Texas (Navarrete and Griffis 2011a). It appears that cranes are not overly susceptible to collision with turbines given that 100,000's sandhill cranes migrate twice annually through the Great Plains and none have been documented as wind turbine collision fatalities in this region during migration (Derby et al. 2012).

Besides direct mortality, concern has also been raised regarding potential displacement impacts that wind facilities may have on whooping cranes. For example, if whooping cranes avoid wind facilities, the likelihood of impacts with turbines is further decreased but the availability of habitat in the project area may be diminished, causing cranes to have to fly further to find suitable habitat to roost and forage. To date, very little quantitative data is available to help address displacement impacts on whooping cranes or sandhill cranes. A recent presentation by Navarrete and Griffis (2011b) suggests that the mean density of sandhill cranes wintering in the high plains of Texas increased the further away from studied wind facilities and this distribution was not a random event. It is unclear if a similar pattern is found in cranes during migration or at other wintering areas.

Although developed for transmission line impacts on whooping crane habitat in Kansas, the Watershed Institute's (2012) potentially suitable habitat assessment for whooping cranes can help to quantify potential whooping crane habitat in and around a proposed wind energy project. This tool indicates that the range of scores and average score at the SFWP is similar to the four other study areas, indicate that overall the site is not unique in providing potential habitat for the species during migration. In addition, the average score and most of the individual wetland scores are much lower than the reference score of 12 developed for quality habitat at the Quivira National Wildlife Refuge.

SUMMARY

In analyzing the potential for significant impacts from wind development on whooping crane stopover habitat, Stehn (2007) suggests assessing whether there is "lots of suitable stopover habitat in the general area … or is the proposed wind farm site the only suitable whooping crane stopover habitat for miles around". This issue was investigated by comparing the potential whooping crane stopover habitat (using wetlands as this indicator) in the project area to surrounding (in the four cardinal directions) areas of the same dimensions, located adjacent (based on the BWP's boundary extent) to the BWP boundary. A Geographic Information System (GIS) was used to calculate the amount of the various habitats and in the case of wetlands, number of individual basins and their type, in each of the areas compared to the proposed SFWP (Tables 1, 2, and 3). This analysis shows that both roosting (i.e. wetlands) and foraging (i.e. croplands) habitats are available in the SFWP and alternate areas. Potential whooping habitat within the SFWP appears to be most similar to that in the east and west reference areas and more suitable than that found in the north and south alternate areas. Based on results from suitable habitat assessment, potential whooping crane use wetlands are similar in attractiveness in all studied areas with the SFWP having the most potential basins (Table 4). While whooping cranes likely migrate over the SFWP and there is potential for roosting or foraging use at the SFWP, the SFWP does not provide significant potential habitat nor does it provide unique habitat compared to adjacent areas.

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